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Proceedings of the Twenty-seventh Annual Meeting of the American Association of Economic Entomologists

The twenty-seventh annual meeting of the American Association of Economic Entomologists was held at the University of Pennsylvania, Philadelphia, Pa., December 28 to 31, 1914.

The meeting of the section on Apiary Inspection was held at 8 p. m., December 28 and the sessions of the section on Horticultural Inspection convened at 8 p. m. December 29 at the Hotel Walton and at 10.30 a. m. December 30 at the University.

The business proceedings of the Association are given in Part I of this report and the addresses, papers and discussions will be found in Part II.

The proceedings of the sections will be prepared by the section secretaries and published as parts of this report.

The meeting was the largest in the history of the Association, the program was very interesting and all present joined in making it a great success.

PART I BUSINESS PROCEEDINGS

The meeting was called to order by President H. T. Fernald at 1.30 p. m., Monday, December 28, 1914.

Over 200 members and visitors attended the sessions, the average attendance at each session being about 150. The following members were present:

A. J. Ackerman, Washington, D. C.
George G. Ainslie, Nashville, Tenn.
J. M. Aldrich, Lafayette, Ind.
I. L. Bailey, Northboro, Mass.
C. H. Baldwin, Indianapolis, Ind.
Nathan Banks, Washington, D. C.
G. G. Becker, Fayetteville, Ark.
Wm. Beutenmuller, New York City.
F. C. Bishopp, Dallas, Texas.
M. W. Blackman, Syracuse, N. Y.

E. B. Blakeslee, Washington, D. C.
W. E. Britton, New Haven, Conn.
C. T. Brues, Forest Hills, Mass.
A. F. Burgess, Melrose Highlands, Mass.
J. W. Chapman, Forest Hills, Mass.
S. C. Clapp, Raleigh, N. C.
C. R. Cleveland, Durham, N. H.
C. W. Collins, Melrose Highlands, Mass.
Mel. T. Cook, New Brunswick, N. J.
R. A. Cooley, Bozeman, Mont.
G. H. Corbett, London, England.
E. N. Cory, College Park, Md.
G. C. Crampton, Amherst, Mass.
C. R. Crosby, Ithaca, N. Y.
J. J. Davis, Lafayette, Ind.
G. A. Dean, Manhattan, Kans.
M. W. Eddy, State College, Pa.
E. B. Engle, Harrisburg, Pa.
E. P. Felt, Albany, N. Y.
H. T. Fernald, Amherst, Mass.
D. E. Fink, Norfolk, Va.
R. J. Fiske, Washington, D. C.
S. A. Forbes, Urbana, Ill.
B. B. Fulton, Geneva, N. Y.
B. N. Gates, Amherst, Mass.
J. B. Gill, Washington, D. C.
C. P. Gillette, Fort Collins, Colo.
Hugh Glasgow, Geneva, N. Y.
H. A. Gossard, Wooster, Ohio.
C. H. Hadley, Jr., Ithaca, N. Y.
Ernest Hargreaves, London, England.
Leonard Haseman, Columbia, Mo.
W. H. Hasey, Amherst, Mass.
I. M. Hawley, Ithaca, N. Y.
T. J. Headlee, New Brunswick, N. J.
Glenn W. Herrick, Ithaca, N. Y.
P. M. Hertzog, Heightstown, N. J.
C. Gordon Hewitt, Ottawa, Canada.
C. E. Hood, Melrose Highlands, Mass.
C. O. Houghton, Newark, Del.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
R. W. Howe, Tallulah, La.
S. J. Hunter, Lawrence, Kans.
W. D. Hunter, Washington, D. C.
J. C. Hutson, Amherst, Mass.
J. A. Hyslop, Hagarstown, Md.
E. O. G. Kelley, Wellington, Kans.
J. L. King, Cleveland, Ohio.
Frederic Knab, Washington, D. C.
J. Kotinsky, Washington, D. C.
G. H. Lamson, Jr., Storrs, Conn.
W. H. Larrimer, Wellington, Kans.
R. W. Leiby, Ithaca, N. Y.
M. D. Leonard, Ithaca, N. Y.
A. D. MacGillivray, Urbana, Ill.
C. L. Marlatt, Washington, D. C.
J. F. Martin, Amherst, Mass.
J. W. McColloch, Manhattan, Kans.
W. R. McConnell, Hagerstown, Md.
L. S. McLaine, Ottawa, Canada.
C. L. Metcalf, Columbus, Ohio.
Z. P. Metcalf, West Raleigh, N. C.
A. P. Morse, Wellesley, Mass.
J. A. Nelson, Washington, D. C.
Henry Ness, Shenandoah, Iowa.
Wilmon Newell, College Station, Texas.
W. C. O'Kane, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
W. A. Osgood, Durham, N. H.
R. R. Parker, Amherst, Mass.
P. J. Parrott, Geneva, N. Y.
L. M. Peairs, Morgantown, W. Va.
W. E. Pennington, Hagerstown, Md.
E. F. Philips, Washington, D. C.
A. L. Quaintance, Washington, D. C.
W. S. Regan, Amherst, Mass.
C. H. Richardson, New Brunswick, N. J.
W. A. Riley, Ithaca, N. Y.
D. M. Rogers, Boston, Mass.
A. G. Ruggles, St. Anthony Park, Minn.
W. E. Rumsey, Morgantown, W. Va.
V. I. Safro, Lexington, Ky.
J. G. Sanders, Madison, Wis.
E. R. Sasscer, Washington, D. C.
H. B. Scammell, Washington, D. C.
W. J. Schoene, Blacksburg, Va.
W. M. Scott, Baltimore, Md.
N. E. Shaw, Columbus, Ohio.
V. E. Shelford, Urbana, Ill.
Franklin Sherman, Jr., Raleigh, N. C.
E. H. Seigler, Washington, D. C.
F. L. Simanton, Washington, D. C.
Henry Skinner, Philadelphia, Pa.
M. T. Smulyan, Blacksburg, Va.
J. N. Summers, Melrose Highlands, Mass.
H. A. Surface, Harrisburg, Pa.
T. B. Symons, College Park, Md.
F. L. Thomas, Athol, Mass.
D. G. Tower, Lafayette, Ind.
E. G. Titus, Logan, Utah.
C. H. T. Townsend, Washington, D. C.
C. F. Turner, Greenwood, Miss.

F. M. Webster, Washington, D. C.
R. L. Webster, Ames, Iowa.
H. B. Weiss, New Brunswick, N. J.
C. B. Williams, Merton, Surry, England.
T. S. Wilson, Wellington, Kans.
Francis Windle, West Chester, Pa.
W. B. Wood, Washington, D. C.
E. L. Worsham, Atlanta, Ga.
L. H. Worthley, Boston, Mass.
W. W. Yothers, Orlando, Fla.

PRESIDENT H. T. FERNALD: You will please come to order. We will now listen to the report of the Secretary.

REPORT OF THE SECRETARY

At the time of the last Annual Meeting the membership of the Association was divided as follows: Active, 131; Associate, 189; Foreign, 53; making a total of 373. At the Atlanta meeting four associate members were transferred to the active list and 36 associate members were elected. At that time two associate and one foreign member resigned. Two active members have died and 5 associate members have been dropped from the roll for non-payment of dues. The present membership is 133 active, 212 Associate, 52 Foreign, a total of 397, making a net gain in membership of 24.

During the past year we have lost by death two active members.

Dr. Wm. Saunders, who for many years was Director of the Central Experimental Farm at Ottawa, Canada, died during the summer of 1914. He was one of the older members of the Association and although he was unable to attend our meetings during recent years maintained a great interest in entomology.

Mr. John A. Grossbeck became a member of the Association during the time that he was an assistant to the late Dr. John B. Smith. In recent years he has been on the entomological staff of the American Museum of Natural History of New York.

For several years the income of the Association has been slightly greater than the outgo, so that a moderate surplus has been accumulated. This has been accomplished only by the most rigid economy. During the past year the expenses have overrun the income so that the surplus has been somewhat decreased. This has been partly due to the fact that no dues for 1915 have been collected on account of the pending amendment to the by-laws relative to the change in the amount of annual dues.

The annual net increase in the number of Active members for the past few years has been very small and the net increase in revenue from the new associate members has usually not amounted to more than ten dollars annually.

THE JOURNAL OF ECONOMIC ENTOMOLOGY

The management of the JOURNAL has endeavored to maintain the good reputation that this publication has enjoyed in the past. It has been necessary to cut expenditures severely, which accounts for the delay in publishing the complete proceedings in the first two numbers of the JOURNAL last spring.

The financial success of the JOURNAL depends on the advertising that can be secured. During the past year a number of firms have curtailed their advertising and replacements have not been easy to secure owing to unsettled business conditions. This loss of income has not been made up by new subscribers as our list showed a net increase of only 15 during the past year. The total receipts dropped $225 from those of the previous year and a corresponding decrease in expenditures has been necessary.

The outlook for the coming year as regards the subscription list is not encourag-

ing. Our foreign subscription list will doubtless be cut heavily on account of the war in Europe and the moderate increase of fifty cents in the annual rate to non-members of the Association as suggested by the Advisory Board at the last meeting is necessary to meet existing conditions.

Expenditures by both the Editor and the Secretary have been curtailed during the past year and this has meant that much more personal attention had to be devoted to the publication than heretofore.

The financial statement which follows shows the present condition of the Treasury. A few bills are outstanding because they have not been presented for payment and a number of good accounts are collectible.

Association Statement

Balance in Treasury, December 22, 1913		$358.79
By amount received for dues 1914		120.94
To stenographic report 1913 meeting	$47.20	
Stamps and stamped envelopes	19.62	
Printing, announcements, etc.	41.50	
Telegraph and express	2.50	
Buttons 1913 meeting	11.12	
Buttons 1914 meeting	11.25	
Cost of Incorporation	3.45	
Clerical work, Secretary's office	30.75	
One half salary of Secretary	50.00	
	$217.39	
Balance, December 22, 1914	262.34	
	$479.73	$479.73

Journal Statement

Balance in Treasury December 22, 1913		$335.81
By amount received for subscriptions, advertising, etc., 1914		1,578.57
To stamps and stamped envelopes	$38.36	
Printing	1,159.13	
Halftones	86.16	
Miscellaneous supplies	26.82	
Clerical work, Editor's office	32.50	
Clerical work, Manager's office	25.00	
Salary, Editor	100.00	
One-half salary of Manager	50.00	
	$1,517.97	
Balance December 22, 1914	396.41	
	$1,914.38	$1,914.38

Respectfully submitted,

A. F. Burgess,
Secretary.

On motion the report was received and the financial part referred to the Auditing Committee.

SECRETARY A. F. BURGESS: I would like to make a few remarks in regard to the JOURNAL. In 1913 we had a paid up subscription list of 705; in 1914, 720. This does not include copies that go to advertisers and possibly a half dozen free copies which are sent to institutions which carry on bibliographical work. Of the 720 paid subscriptions, 142 went to foreign countries, almost every country in the world being represented. We have a large foreign list of subscribers but I expect that it will be cut very heavily this year on account of the war.

At the last meeting of the Association, the Advisory Committee brought in a report recommending that the subscription price of the JOURNAL be raised 50 cents, provided an amendment to the by-laws raising the dues was accepted at this meeting. We do a large business with subscription agencies. It is necessary for them to prepare catalogues and quote prices in mid-summer. As it was impossible to wait for a decision at this meeting in regard to raising the price of the JOURNAL, I increased it in my quotations to subscription agencies.

We have been receiving a considerable number of subscriptions from Japan during the past year and a noticeable increase of subscriptions to Russia was made during 1914.

I wish to explain this matter so that the members will understand more accurately how the JOURNAL stands at the present time.

PRESIDENT H. T. FERNALD: I will now read the Report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

No meeting of the Executive committee has been necessary during the year, only two matters having arisen which needed consideration.

The first of these was a renewal of the invitation by the Managers of the Panama-Pacific Exposition to hold a meeting at San Francisco during the coming summer. After correspondence between the members of the committee it seemed desirable to avoid breaking in on our present custom of holding our regular annual meeting during the Christmas holidays, and the invitation was therefore declined. Since that time certain developments seem to make it desirable to bring this subject before the Association where it will be presented as new business.

The other matter was the preparation of a seal, authorized at the last annual meeting. The committee is not yet ready to make a final report as to what this seal shall represent and can at present only report progress.

H. T. FERNALD,
GLENN W. HERRICK,
W. E. BRITTON,
WILMON NEWELL,
A. F. BURGESS,
Executive Committee.

PRESIDENT H. T. FERNALD: The next on the program is the

report of the Employment Bureau by W. E. Hinds, Auburn, Alabama, which will be read by the Secretary.

ANNUAL REPORT OF ENTOMOLOGISTS' EMPLOYMENT BUREAU

General Statement

The Entomologists' Employment Bureau was established three years ago for the mutual convenience of both employers and employees in entomological work. The service incident to bringing these two parties together has from the first been conducted at the minimum of expense.

Under the administration of Prof. F. L. Washburn who had charge of the Bureau for the first two years of its existence, some twenty men were enrolled and a number of appointments appear to have been made through the agency of the Bureau. The registration fee was reduced from $4.00 to $2.00. No definite limit appears to have been set as to the service offered and no special forms were used in the records of the Bureau. It has seemed necessary therefore to systematize the work somewhat more than was necessary at its inception.

Accordingly enrollment and notification forms, letterheads, etc., have been prepared so that we may be in position to give prompt and effective service with a minimum of clerical expense. The information needed by applicants for enrollment is printed on the application form itself. Ten references to possible employers are offered with one registration fee. An abstract of the enrollment record, with full addresses of parties whose names are given as references is now sent to the possible employer and a notice of the opening for which a man is apparently prepared is sent to each man whose name has been suggested in connection therewith.

These changes in method of administration are working satisfactorily. It happens occasionally, however, that an applicant moves for some reason without sending us his new address, thus putting us out of touch with him for a time at least. It would help the Bureau to become of greater service if we may have a little more general coöperation in the following points especially: First, Prompt notification of changes in the applicant's address. Second, More general notification by employers regarding positions for which names of candidates may be desired. Our service is free to employers and we can frequently suggest the names of several men having the general qualifications required so that the employer may have a choice among several good men. Third, We need more general information regarding appointments, especially when made through the agency of the Bureau and when men enrolled with the Bureau accept work either temporary or permanent, which might change their status as applicants whose names we might present for immediate appointments.

Since March 3, 1914, we have added nineteen (19) new names to the enrollment list and at least eight (8) appointments have been made from names supplied by the Bureau. A full financial statement is presented herewith.

W. E. Hinds,
In Charge.

Financial Statement

Received

March 3, 1914, To check of F. L. Washburn covering balance on hand	$32.25
March to December, To nineteen (19) new registrations	38.00
Total receipts	$70.25

		Paid
August 25, 1914, Printing and stationery, Post Publishing Co....		$11.00
October 5, Post Publishing Co.....		2.00
April 9, August 29, November 5. Labor multigraphing letters: $1.00, 75c, 75c.....		2.50
Postage.....		7.24
Envelopes and letter heads furnished by A. P. I., Dept. of Entomology.....		2.50
December 22, Stenographer, N. C. Powell.....		18.00
Total expenditures.....		$43.24
Balance, in Bank of Auburn.....		27.01
	$70.25	$70.25

W. E. HINDS,
In Charge.

On motion the report was adopted and the financial part referred to the Auditing Committee.

SECRETARY A. F. BURGESS: I notice that Mr. Hinds emphasizes the necessity for members notifying him promptly of any change of address. I want to make the same point in regard to subscribers to the JOURNAL. Entomologists are a very migratory set of people and if you had the mailing list of the JOURNAL to correct for each issue, you would realize that fact. In order to assure delivery of the publication as it is issued, it is necessary that the members should promptly notify concerning any change of address.

PRESIDENT H. T. FERNALD: The report of the Committee on nomenclature will now be presented by Mr. Herbert Osborn, Columbus, Ohio.

REPORT OF COMMITTEE ON COMMON NAMES OF INSECTS OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The only case which has been submitted to your committee during the past year has been a petition from Dr. H. J. Franklin of Amherst, Mass., to the effect that the names of certain cranberry insects, the Black-head Cranberry Worm and the Yellow-head Cranberry Worm, names which were adopted on the initiative of Prof. J. B. Smith, should be changed to the Flowed Bog Fireworm, *Rhopobota vacciniana* (Pack.) and the Dry Bog Fireworm, *Peronea minuta* (Rob.).

Dr. Franklin's argument in brief is that the names suggested are more distinctive of the habits of the species concerned and that the previous names are less distinctive and less suggestive to the practical cranberry growers who are especially interested in the use of these names.

Your committee feels that it is undesirable to make changes of names already adopted except in case of very positive reasons and would present the case to the Society without recommendation.

We will be pleased to have the matter discussed at this meeting and the opinions of those entomologists most familiar with the species considered in the discussion.

Respectfully submitted,

HERBERT OSBORN,
W. E. BRITTON,
E. P. FELT,
Committee.

SECRETARY A. F. BURGESS: It seems to me that it would be well for the committee to take up the suggested changes with the entomologists that are particularly interested in cranberry insects and bring in a recommendation later to the Association. Cranberries are grown only in limited sections of the country, and there are therefore only a limited number of our members interested in these insects. It ought to be possible for the committee to consult with these men and get the consensus of opinion in regard to the proposed changes in names.

On motion, the report was referred back to the committee with instructions to report later.

PRESIDENT H. T. FERNALD: Next is the report of the committee on entomological investigations which will be read by Glenn W. Herrick, Ithaca, N. Y.

REPORT OF THE COMMITTEE ON ENTOMOLOGICAL INVESTIGATIONS

December 23, 1914

MR. PRESIDENT:

The Committee on Entomological Investigations presents its report and begs leave to make the following remarks:

The notice to the different entomologists was sent out a little late, owing to a confusion regarding the organization of the Committee. However, about the same number have reported as usual. In addition, we have this year for the first time, the long list of most admirable projects of the Bureau of Entomology at Washington.[1] Lists of projects of other entomologists are not readily accessible and are therefore reproduced below.

GLENN W. HERRICK,
WALTER C. O'KANE,
T. J. HEADLEE,
Committee.

INVESTIGATIONS DEALING WITH MAMMALIA

Nebraska, Lincoln,—Myron H. Swenk.
The prairie-dog. Substantial progress. Preliminary publication contemplated.
New Mexico, State College,—D. E. Merrill.
Prairie-dogs. Data on distribution, numbers, damage, control.
Rodents. Tests of poisons, traps, etc. Scattering.

[1]This latter is not reprinted, since it appears in the "Program of Work of the United States Department of Agriculture for the Fiscal Year 1915" and may be readily obtained by interested parties.

Investigations Dealing with Crustacea

Mississippi, Agricultural College,—R. W. Harned.
The crayfish of Mississippi. Slight progress during the year.

Investigations Dealing with Mollusca

Oregon, Corvallis,—H. F. Wilson.
The garden slugs. Begun 1913. A. L. Lovett in immediate charge.

Investigations Dealing with Acarina

Connecticut, New Haven,—W. E. Britton.
Control of Greenhouse Mite, *Tarsonemus pallidus* Banks. Begun 1914. Q. S. Lowry aiding.

Montana, Bozeman,—R. A. Cooley.
Tick investigations with particular reference to *Dermacentor venustus*.

North Carolina, Raleigh,—Franklin Sherman, Jr.
Red spider on cotton. Life history, habits; begun last year; continued.

New York, Geneva,—P. J. Parrott.
Monographic study of the *Eriophyidæ* of N. Y. In charge of H. E. Hodgkiss.

Investigations Dealing with Thysanoptera

Connecticut, New Haven—W. E. Britton.
Control of Onion Thrips, *Thrips tabaci* Linde. Begun 1913. B. H. Walden aiding.

New York, Geneva,—P. J. Parrott.
Life history, habits, distribution in New York of the pear thrips, *Euthrips pyri*.

Investigations Dealing with Mallophaga and Anoplura

California, Stanford University,—V. L. Kellogg.
Taxonomic and biologic studies of the Mallophaga and Anoplura. (With G. F. Ferris). Generic and specific revision of the North American Anoplura. Work under way.

New York, Cornell University, Ithaca,—Glenn W. Herrick.
The Mallophaga of domestic fowls. Ready for publication.

Investigations Dealing with Isoptera

Kansas, Manhattan,—George A. Dean and J. H. Merrill.
A study of the termite (*Termes lucifugus*).

Investigations Dealing with Orthoptera

Hawaii, Honolulu,—J. F. Illingworth.
Monograph of Hawaiian Roaches, begun 1913, well under way.

Idaho, Boise,—T. H. Parks.
Snowy tree cricket (*Oecanthus niveus*). Injuries to ripening prunes. Begun 1914.

Kansas, Lawrence,—S. J. Hunter.
Acridinæ of Kansas, taxonomic, economic and biologic phases. P. W. Claassen in charge.
Remedial measures against native grasshoppers. S. J. Hunter and P. W. Claassen.

Kansas, Manhattan,—George A. Dean.
Habits and life history, control of injurious grasshoppers. George A. Dean.
Parasitic and predaceous enemies of grasshoppers. Paul S. Welch.

Nebraska, Lincoln,—Myron H. Swenk.
Grasshopper control. Lawrence Bruner in charge. Substantial progress.

New York, Albany,—E. P. Felt.
Grasshoppers of New York, control. Considerable data. Begun 1914.

New York, Geneva,—P. J. Parrott, B. B. Fulton.
Life histories, habits and control of tree crickets, *O. nireus* and related species.

Oregon, Eugene,—C. F. Hodge.
Methods of collecting and preserving grasshoppers for game bird and poultry food.

INVESTIGATIONS DEALING WITH HEMIPTERA

Arkansas, Fayetteville,—George C. Becker.
(1) Supposed immunity of Northern Spy stock to the attacks of woolly aphis.
(2) Studies of the relationship of woolly aphis to its various hosts. Substantial progress.

Colorado, Boulder,—T. D. A. Cockerell and Elizabeth Robinson.
Coccidæ of Colorado and Philippine Islands. One paper published; second about to be published.

Colorado, Fort Collins,—C. P. Gillette.
Plant aphids. Several years' progress. Much data accumulated; two papers published.

Florida, Gainesville,—J. R. Watson.
White fly studies.

Idaho, Boise,—T. H. Parks.
Clover aphis (*Aphis bakeri*). Begun 1913; studied as an enemy of red clover and apple foliage.

Indiana, Indianapolis,—C. H. Baldwin.
Coccidæ of Indiana. Distribution, control of greenhouse species. H. F. Dietz in charge.

Maine, Orono,—Edith M. Patch.
Aphid ecology. Begun 1904. Progress slow but constant.

Mississippi, Agricultural College,—R. W. Harned, E. W. Stafford.
Scale insects of Mississippi (food habits, life history of native species).

Missouri, Columbia,—L. Haseman.
Tarnished plant bug and its work on peach and other plants.
Apple leaf hopper.
Control of the San José scale. L. Haseman and A. H. Hollinger.

Missouri, Mountain Grove,—M. P. Somes.
Life history and control of the San José scale. Satisfactory progress.
Life history and control of *Jalysus spinosus*. Practically complete.

Montana, Bozeman,—R. A. Cooley.
Life history and control of sugar beet louse (*Pemphigus betæ*). J. R. Parker in charge.
Control of the oyster shell scale by use of insecticides.

Iowa, Ames,—R. L. Webster.
Oyster shell scale, *Lepidosaphes ulmi*. Begun 1908. Progress satisfactory.

Kansas, Lawrence,—S. J. Hunter.
Aspidiotus perniciosus, study of means of distribution and methods of control.
Aspidiotus perniciosus, study of the natural parasites. P. W. Claassen.
Blissus leucopterus, control measures. S. J. Hunter and P. W. Claassen.
Woolly aphis, H. B. Hungerford.
Toxoptera graminum, Ruby Hosford.

Kansas, Manhattan,—Geo. A. Dean.
Chinch bug control. Geo. A. Dean and J. W. McColloch.
Chinch bug egg parasite. J. W. McColloch.
Control of San José scale. J. H. Merrill.

New York, Albany,—E. P. Felt.
Efficiency of San José scale parasites. Preliminary report in type. Begun in 1913.

New York, Geneva,—P. J. Parrott.
Life history, habits, control in pear orchards of false tarnished plant-bug, *Lygus invitus* Say. H. E. Hodgkiss in immediate charge.
Control of late summer broods of the pear psylla. H. E. Hodgkiss in immediate charge.
Life history, habits, control of grape leaf hopper. F. Z. Hartzell in immediate charge.

New York, Cornell University, Ithaca,—Glenn W. Herrick.
Green apple aphis (*Aphis pomi*). Robert Matheson in full charge.
Rosy apple aphis (*Aphis sorbi*). Robert Matheson in full charge.
Pine leaf scale (*Chionaspis pinifoliæ*). Robert Matheson in full charge.

Ohio, Wooster,—H. A. Gossard.
Biological and economic studies of plant lice, especially in orchards.
Distribution of Periodical Cicada, 1914 brood; coöperation with Biological Survey and State Bureau of Nursery Inspection.
Experiments for control of jassids or leaf-hoppers in grasslands planned.
Scale insects and remedies; much experimental data. J. S. Houser in immediate charge.
Woolly aphis. Several years' work, not much progress. J. S. Houser in immediate charge.
Research on Pentatomidæ. Several life histories practically complete. R. D. Whitmarsh in immediate charge.

Oregon, Corvallis,—H. F. Wilson.
Rose-leaf hopper as a fruit tree pest (*Empoa rosæ*). Begun July 1, 1914. Leroy Childs aiding.

South Carolina, Clemson College,—A. F. Conradi.
Aphis maidi-radicis on cotton; life history, food plants, ants, repellants, control. Begun 1909. W. A. Thomas in charge.

South Dakota, Brookings,—H. C. Severin.
Investigations of the scale insects of South Dakota. Begun in 1912.

Tennessee, Knoxville,—E. C. Cotton.
The hog louse.

Texas, College Station,—Wilmon Newell.
Turnip louse (*Aphis pseudobrassicæ*). Well advanced; preliminary publication being prepared. F. B. Paddock in charge. Begun in 1913.

Virginia, Blacksburg,—W. J. Schoene.
Spinach aphis (*Myzus persicæ*), control, L. B. Smith in charge; project started spring of 1914.
Pea-aphis (*Macrosiphum pisi*) biology and control, L. B. Smith in charge; project started spring of 1914.
Biology and the control of the three species of the aphis affecting the apple. *Aphis pomi*, *Aphis sorbi* and *Siphocoryne avenæ*. W. J. Schoene and M. T. Smulyan in charge; project started spring of 1914.
Effect of woolly aphis (*Schizoneura lanigera*) on apple trees. W. J. Price in charge; continuation of a project of several years' standing.

West Virginia, Morgantown,—L. M. Peairs.
Control of apple woolly aphis. Work along new lines merely started.

INVESTIGATIONS DEALING WITH LEPIDOPTERA

Arkansas, Fayetteville,—George C. Becker.
Life history, control of *Sanninoidea exitiosa*. Substantial progress.

Colorado, Fort Collins,—C. P. Gillette.
Codling moth; in progress for several years. Much data.

Hawaii, Honolulu,—J. F. Illingworth.
Palm-leaf roller (*Omoides blackburni* Butl.), seasonal activity, life history, parasites. Begun 1913, well under way.

Indiana, Indianapolis,—C. H. Baldwin.
Apple-leaf skeletonizer, life history, control. Begun 1914. Progress satisfactory.

Indiana, Lafayette,—James Troop.
Life history, control, codling moth. Begun 1913. Will run one or two years more.

Iowa, Ames,—R. L. Webster.
Strawberry leaf-roller (*Ancylis comptana*). Begun 1913. Considerable data.
Variegated cutworm (*Peridroma margaritosa*). Begin in 1914. Many observations.
Corn-ear worm (*Heliothis obsoleta*). Seasonal history. Begun in 1914.

Kansas, Lawrence,—S. J. Hunter.
Codling moth, control. S. J. Hunter and P. W. Claassen.
Indian meal-moth, life history and economic importance. S. J. Hunter & R. H. Beamer.
Cut-worms and army-worms, economic phases. H. B. Hungerford and Geo. H. Vansell.
Bee-moth. Geo. H. Vansell.

Kansas, Manhattan,—Geo. A. Dean.
Life history and control of the the corn-ear worm. J. W. McColloch.
Life history and control of the apple-leaf skeletonizer (*Canarsia hammondi*). J. H. Merrill.

Maryland, Baltimore,—W. M. Scott.
Experiments for the control of the peach tree borers. Begun 1913.

Missouri, Columbia,—L. Haseman.
Life history; paints for control of peach tree borer. L. Haseman and M. E. Hays.
Life history, injury, control of corn-ear worm. M. E. Hays.

Missouri, Mountain Grove,—M. P. Somes.
Life history and control of peach tree borer. Considerable progress.

Montana, Bozeman,—R. A. Cooley.
Life histories and control of cutworms.

Nebraska, Lincoln,—Myron H. Swenk.
Cutworm injury to Nebraska crops. Considerable data.

New Jersey, New Brunswick,—T. J. Headlee.
Corn-ear worm investigations; methods of applying powdered poisons. C. H. Richardson and T. J. Headlee; see Rept., 1913.
Peach borer: study of protective coatings. H. B. Weiss and T. J. Headlee. See Repts., 1913, 1914.

New York, Albany,—E. P. Felt.
Efficiency of codling moth sprays. Mostly published. Begun in 1909.

New York, Geneva,—P. J. Parrott.
Life history, habits, distribution of the apple and cherry ermine moths.
Life histories of species of *Xylina* and *Scopelosoma*. B. B. Fulton in immediate charge.

Ohio, Wooster,—H. A. Gossard.
Life history of codling moth at Wooster; some data, studies of second brood in all sections of state.
Life history and economics of clover leaf-roller. Notes for three or four seasons.
Control of grapeberry worm. Experimental work practically finished. Life history incomplete. W. H. Goodwin in charge.
Life history and control of peach tree borer; two years' observations; substantial progress; large remedial tests. J. L. King in immediate charge.
Life history and treatment for the lesser peach borer, as in preceding.

Pennsylvania, Harrisburg,—H. A. Surface.
Experiments for control of the peach tree borer. Work completed.

South Dakota, Brookings,—H. C. Severin.
Life history and control of native cutworms. Begun in 1910.

INVESTIGATIONS DEALING WITH DIPTERA

Colorado, Fort Collins,—C. P. Gillette.
Syrphus flies and plant lice; continued three years; considerable material. C. R. Jones in immediate charge.
Life habits of the lady beetles. Paper published. Miss M. A. Palmer in immediate charge.

Connecticut, New Haven,—W. E. Britton.
Cabbage maggot control. Begun 1908. Q. S. Lowry aiding.
Onion maggot control. Begun in 1914. B. H. Walden aiding.

Connecticut, New Haven,—W. E. Britton.
Control of mosquitoes in Connecticut; effect of drainage on salt marsh; changes in flora. Begun 1912. B. H. Walden aiding.

Hawaii, Honolulu,—J. F. Illingworth.
Melon flies (*Dacus cucurbitæ* Coq.), control measures, begun 1914, well started.

Kansas, Lawrence,—S. J. Hunter.
Tabanidæ of Kansas, R. H. Beamer.
Simulium, study of connection with transmission of Pellagra. S. J. Hunter.
Similium, Ecology and morphology. H. B. Hungerford.
Hessian fly, methods of control. S. J. Hunter and P. W. Claassen.

Kansas, Manhattan,—Geo. A. Dean.
Life history and control of the Hessian fly. Geo. A. Dean and J. W. McColloch.

Massachusetts, Amherst,—H. T. Fernald.
Control of onion maggot on large fields. Progress satisfactory.

Missouri, Columbia,—L. Haseman.
Life history of the Hessian fly and resistant varieties of wheat.

New Hampshire, Durham,—W. C. O'Kane and C. H. Hadley, Jr.
Control of root maggots with insecticides; two seasons' preliminary work completed.
Control of black flies, deer flies and midges. In progress.

New Jersey, New Brunswick,—T. J. Headlee.
Typhoid fly: Data necessary for practical control work of it and its associates. Charles S. Beckwith and T. J. Headlee in 1913, C. H. Richardson in 1914. See reports 1913, 1914.
Mosquito investigations: Data for practical control work. T. J. Headlee. See reports 1913, 1914, also Circ. 17.

New York, Albany,—E. P. Felt.

Monographic study of biology and taxonomy of gall midges. Partly published, much in manuscript. Begun in 1906.

New York, Geneva,—P. J. Parrott.

Life history, habits, control of the grape midge. F. Z. Hartzell in immediate charge.

Life history, habits, control of cabbage maggot; a special study of the reaction of puparia to heat and desiccation; methods of protecting seed beds. Ready to report. W. J. Schoene.

Ohio, Wooster,—H. A. Gossard.

Onion maggot. Observations for two seasons, substantial progress. J. S. Houser in immediate charge.

Oregon, Eugene,—C. F. Hodge.

Control of house and stable flies, especially community coöperation in practical extermination. Begun 1910.

Preventing mosquito breeding in agricultural districts; in conjunction with class in biology.

INVESTIGATIONS DEALING WITH COLEOPTERA

Alabama, Auburn,—W. E. Hinds.

Life history, control of rice or black weevil, *Calandra oryza*. Substantial progress. Begun 1908. Partly published.

Arkansas, Fayetteville,—George C. Becker.

Life history, habits, control of *Saperda candida:* (1) life history and habits, (2) control. Substantial progress.

Connecticut, New Haven,—W. E. Britton.

Life history and control of white pine weevil, *Pissodes strobi* Pk. Begun 1911. B. H. Walden aiding.

Hawaii, Honolulu,—J. F. Illingworth.

Cucurbit stem borer (*Apomecyna pertigera* Thoms.), life history, control, begun 1913, well under way.

Monkey pod borer (*Xystrocera globosa* Oliv.), begun 1914, well under way.

Iowa, Ames,—R. L. Webster.

White grub investigations. Begun in 1914; coöperation U. S. Bureau of Entomology.

Kansas, Lawrence,—S. J. Hunter.

Elm-tree borers, life history and control measures, Walter Wellhouse.

Cottonwood borer, parsites of. H. B. Hungerford.

Kansas, Manhattan,—Geo. A. Dean.

Life history, control of maize bill bug (*Sphenophorus maidis*). J. W. McColloch and W. P. Hayes.

Missouri, Columbia,—L. Haseman.

Life history and control of the striped cucumber beetle.

Life history, injury and control of the elm-tree borer.

Missouri, Mountain Grove,—M. P. Somes.

Life history and control of the fruit-tree bark-beetle. Considerable data.

New York, Albany,—E. P. Felt.

Ecology and control of June beetles and white grubs. Partly published. Begun in 1912.

New York, Geneva,—P. J. Parrott.

Life history, control of the rose chafer. F. Z. Hartzell in immediate charge.

Life history, habits, control of grape root worm. F. Z. Hartzell in immediate charge.

Life history, control of the sinuate borer (*Agrilus sinuatus*). Hugh Glasgow in immediate charge.

Distribution, life history, control of *Polydrosus impressifrons*. Hugh Glasgow in immediate charge.

New York, Cornell University, Ithaca,—Glenn W. Herrick.

Poplar borer (*Cryptorhynchus lapathi*). Robert Matheson in full charge.

Ohio, Wooster,—H. A. Gossard.

Life history and systematic studies of long-horned wood-borers in Ohio; continued several years. W. H. Goodwin in immediate charge.

Life history and study of the *Balininæ* or nut weevils of Ohio; continued several years. W. H. Goodwin in immediate charge.

General study of the various bark beetles in Ohio; substantial progress. J. L. King, in immediate charge.

Oregon, Corvallis,—H. F. Wilson.

Otiorhynchid beetles infesting the strawberry in Oregon. Begun July 1, 1914. G. F. Moznette aiding.

Cucumber beetles (*Diabrotica soror* and *D. trivittata*). Begun 1913. A. L. Lovett in immediate charge.

Scolytidæ infesting the Douglas fir (*Pseudotsuga taxifolia* (Pow.)Britt.). Begun 1912. Leroy Childs aiding.

South Carolina, Clemson College,—A. F. Conradi.

A study of new and little known wire-worms of field crops. Begun 1909.

Life histories, food plants, habits, control of *H. uhleri* and *Monocrepidius vespertinus*. Substantial progress.

Above in coöperation with the Section of Southern Field Crop insects, Bureau of Entomology, H. C. Eagerton in charge.

Texas, College Station,—Wilmon Newell.

Pecan twig girder (*Oncideres texana*). Sherman W. Bilsing in charge. Material progress, begun 1913.

Pea and bean weevils; practical control. Work begun. Wilmon Newell and associates.

Wisconsin, Madison,—J. G. Sanders.

Control of white grubs. Begun 1914. Progress satisfactory.

Investigations Dealing with Hymenoptera

Colorado, Boulder,—T. D. A. Cockerell.

Bees of the world; principally those of North America and Australia.

Hawaii, Honolulu.—J. F. Illingworth.

Predaceous habits of big-headed ant (*Pheidole megacephala* Fab.), notes from Fiji Islands and Hawaii, begun 1913, half completed.

Indiana, Indianapolis,—C. H. Baldwin.

Control of house ants. Begun 1914.

Kansas, Lawrence,—S. J. Hunter.

Bees and their diseases. Geo. H. Vansell.

Bees and poison bait. Geo. H. Vansell.

Kansas, Manhattan,—Geo. A. Dean.

A study of the kaffir ant (*Solenopsis molesta*). J. W. McColloch and W. P. Hayes.

Missouri, Columbia,—L. Haseman

A study of beekeeping in Missouri.

New Jersey, New Brunswick,—T. J. Headlee.

Bee disease control: E. G. Carr and T. J. Headlee. See reports for 1913, 1914.

New York, Geneva,—P. J. Parrott.

Life history, habits, control of the saw fly leaf miner (*Profenusa collaris* MacG). B. B. Fulton in immediate charge.

Oregon, Corvallis,—H. F. Wilson.

Raspberry and loganberry rootborer (*Bembecia marginata*). Begun 1913. A. L. Lovett in immediate charge.

Texas, College Station,—Wilmon Newell.

A study of inheritance in the honey bee. Material progress. Begun in 1911.

Beekeeping experiments.

Practical experiments relating to honey production. Begun in 1912.

Wisconsin, Madison,—J. G. Sanders.

Wisconsin beekeeping conditions. Begun in 1912. L. V. France in charge.

INVESTIGATIONS DEALING WITH GROUPS OF INSECTS OR WITH INSECTICIDES OR WITH BOTH

Alabama, Auburn,—W. E. Hinds.

Carbon bisulphide and hydrocyanic acid gas as insecticides. Begun 1908. Continued progress.

Factors affecting the distribution, adhesion, economy of application and efficiency of arsenical insecticides with particular reference to arsenate of lead; begun 1913. Substantial progress.

Colorado, Boulder,—T. D. A. Cockerell.

Insects of Colorado, principally those of Boulder County.

Fossil insects especially of Florissant, Colorado (Principally Diptera and Hymenoptera.)

Colorado, Fort Collins,—C. P. Gillette.

Control of insects by treatment of the eggs. Conducted for several years, much data.

Connecticut, New Haven,—W. E. Britton.

Preparation and application of nicotine solutions as insecticides. Begun 1914. A few extractions and analyses made. J. P. Street aiding.

Study of insects attacking the apple in Connecticut. Begun 1907. Studies completed on several insects and papers published.

Insects attacking the peach in Connecticut. Extent of damage and methods of control. Begun 1907. Studies of a number of the more important pests made.

Control of peach and apple borers in Station orchard. Begun 1911. Considerable data.

Insects attacking cabbage in Connecticut. Substantial progress. Begun 1912. Q. S. Lowry aiding.

Insects attacking vegetables in Connecticut. Begun 1908. Substantial progress.

Insects attacking white pine in Connecticut. Begun 1912. Some progress. B. H. Walden aiding.

Indiana, Indianapolis,—C. H. Baldwin.

Control of greenhouse pests by fumigation and spraying. Begun 1914. A. P. Swallow in charge.

Kansas, Lawrence,—S. J. Hunter.

Alfalfa insects. Wm. Brown.

Spraying; relative efficiency of lime-sulphur and scalecide. P. W. Claassen.

Spraying; effects of successful seasonal spraying on succeeding seasons' crops. S. J. Hunter and P. W. Claassen.

Optimum and fatal temperatures for insect life. Ruby Hosford and Wm. Brown.

Kansas, Manhattan,—Geo. A. Dean.

Relation of climate to injurious insects. Geo A. Dean and J. W. McColloch.

Measures of controlling mill and stored grain insects. Geo. A. Dean.

Maryland, Baltimore,—W. M. Scott.

Development of a dry material for use as a substitute for lime-sulphur solution. Begun 1913.

Experiments with arsenate of lime or calcium arsenate as a substitute for arsenate of lead. Begun 1913. Nearly completed.

Massachusetts, Amherst,—H. T. Fernald.

Causes producing burning of foliage by insecticides. Progress satisfactory.

Real amount of benefit obtained from different groups of parasites. Progress satisfactory.

Distribution limits of pests in Massachusetts. Progress satisfactory.

Strength of fumigation safe on different greenhouse crops as compared with strength necessary for destruction of the pests. Temporarily discontinued.

Michigan, East Lansing,—R. H. Pettit.

How contact insecticides kill. E. G. Shafer in immediate charge.

Life histories and control of various fruit and field crop insects.

Life histories and control of insects injurious to Michigan forests and shade trees. G. C. Goodwin in immediate charge.

Missouri, Columbia,—L. Haseman.

Life histories, distribution, injury and control of insects affecting nursery stock.

Nebraska, Lincoln,—Myron H. Swenk.

The rôle of insects in tripping alfalfa blossoms and effect of tripping on size of seed crop. Progress satisfactory. Preliminary publication contemplated.

A monographic account of the insect enemies of alfalfa. Progress satisfactory.

New Jersey, New Brunswick,—T. J. Headlee.

Spraying and dusting investigations: Effectiveness of certain new dusts in controlling insects and diseases affecting orchard fruits and potato foliage; former this year in charge department of plant pathology and latter in charge of department of entomology. H. B. Weiss, C. H. Richardson and T. J. Headlee in 1913; Alfred E. Cameron in 1914. See reports for 1913, and 1914.

Climatic and insect investigations: Effect of maximum and minimum temperatures on various seriously injurious insects. C. H. Richardson and T. J. Headlee. No printed records of progress thus far.

Insect control: Facts relative to importation of injurious insects from Foreign countries; control of outbreaks of established insects. H. B. Weiss and T. J. Headlee. See reports for 1913, 1914.

New York, Albany,—E. P. Felt.

Factors influencing distribution and abundance of insects. Considerable data accumulated, not much published. Begun in 1899.

Effect of applications of petroleum or petroleum compounds to dormant trees. Much published, investigations still in progress. Begun in 1911.

New York, Cornell University, Ithaca,—Glenn W. Herrick.

Insects injurious to hops in New York. I. M. Hawley in charge. Work just begun.

Insects injurious to clover. C. H. Hadley, Jr., in charge.

New York, Geneva,—P. J. Parrott, and W. J. Schoene.

Insecticidal properties of various sulphides and polysulphides.

Ohio, Wooster,—H. A. Gossard.

Relation of insects to fire-blight in orchards. Preliminary experiments during one season. Commenced in 1907.

Collect grasshoppers and mosquitoes to make a representative collection. Good collection of grasshoppers; only a beginning with mosquitoes.

Shade tree and forest insects. Observations and experimental data collected through several years. J. S. Houser, in immediate charge.

Spraying mixtures. Considerable testing with newer mixtures, especially for scale control. J. S. Houser in immediate charge.

Stored Grain Insects. Experiments with heat and moisture carried on for several years. W. H. Goodwin in immediate charge.

Spraying Machinery Studies. Illustrative types and demonstration machine sectioned to show construction. Improvements and new features. Carried on for several years. Mostly published. W. H. Goodwin in immediate charge.

Important fruit insects in the Lake Erie Fruit Belt. Two years observations. J. L. King in immediate charge.

Household insects. New developments investigated. R. D. Whitmarsh in immediate charge.

Oregon, Corvallis,—H. F. Wilson.

Insecticides and combination sprays. Begun 1912.

Pennsylvania, Harrisburg,—H. A. Surface.

Varieties of cultivated plants, especially fruits, in reference to their liability to insect and plant disease injury. Progress slow.

Improvement of the lime-sulfur solutions. Completed.

Practical dissemination of insect parasites, especially of San José scale.

Native reptiles and amphibians as enemies of insects.

South Carolina, Clemson College,—A. F. Conradi.

Relation of temperature and moisture to insect activity. Begun 1910. Progress slow.

Effect of oils on gloomy and cottony maple scales. Begun 1911. Good success.

West Virginia, Morgantown,—L. M. Peairs.

The relation of temperature to insect life. Begun in 1904 by Professor Sanderson. Satisfactory progress.

Dusting in the orchard. Sufficiently complete for preliminary report.

Dusting for truck crop insects. Fair progress.

Minor orchard insects. Determination of distribution and damage from minor pests.

Control of apple and peach borers. Considerable data. W. E. Rumsey.

Wisconsin, Madison, J. G. Sanders.

Control of onion maggot and other onion insects. Begun 1910, discontinued until 1912 and continued up to 1914.

Tobacco insects of Wisconsin. Mr. Stewart C. Chandler in charge. Begun 1914. Progress satisfactory.

Insects injurious to truck crops in Wisconsin. Neale F. Howard in charge. Begun 1914. To be continued.

Taxonomic Directory

Thysanoptera.

W. E. Hinds, Auburn, Ala., will classify for privilege of retaining duplicates and of naming and describing the new species.

Mallophaga and Anoplura.

V. L. Kellogg, Stanford University, Cal., will classify collections (under reservation as to available time) for usual privileges; especially glad to examine material from mammals.

ORTHOPTERA.

R. A. Cooley, Bozeman, Mont., will classify *Orthoptera* of the Northwest.

B. H. Walden, New Haven, Conn., will classify, in so far as other work will permit.

MEMBRACIDÆ, JASSIDÆ, CERCOPIDÆ and FULGORIDÆ.

Z. P. Metcalf, West Raleigh, N. C., will classify for permission to retain new and unusual forms for further study, and to dispose of a fair number of such forms as he may see fit.

JASSIDÆ.

E. D. Ball, Logan, Utah, will classify North American forms under the usual conditions.

APHIDIDÆ.

C. P. Gillette, Fort Collins, Colo., will classify, provided data on food plants and date and location of capture are furnished, and the privilege of retaining the specimens of special interest when there are duplicates.

H. F. Wilson, Corvallis, Oregon, will classify *Aphididæ* if data on food plants, dates and location of capture are furnished. The correct scientific name of the food plant should be given. Material in the subfamily *Lachninæ* is especially desirable.

APHIDIDÆ and PSYLLIDÆ.

Edith M. Patch, Orono, Maine, will classify on receipt of mature material in good condition with record of food plant accurately determined on which the species developed.

ALEYRODIDÆ.

J. R. Watson, Gainesville, Fla.

COCCIDÆ and ALEYRODIDÆ.

W. E. Britton, New Haven, Conn., will classify in so far as other work will permit.

COCCIDÆ.

J. G. Sanders, Madison, Wis., will classify species of the genus *Lecanium*.

R. A. Cooley, Bozeman, Mont., will classify the genera *Chionaspis*, *Hemichionaspis* and *Phenacaspis* of the world.

R. H. Pettit, East Lansing, Mich., will classify in so far as other work will permit.

HETEROPTERA.

Paul S. Welch, Manhattan, Kansas, will classify, in so far as other work will permit, aquatic *Heteroptera*.

SARCOPHAGIDÆ of the U. S.

R. R. Parker, Amherst, Mass., will classify.

CHIRONOMIDÆ and MYCETOPHILIDÆ.

O. A. Johannsen, Cornell University, Ithaca, N. Y., will classify for the privilege of retaining desiderata.

MUSCOID FLIES.

Charles H. T. Townsend, U. S. National Museum, Washington, D. C., will classify as time permits. Will send names in return for specimens.

EMPIDIDÆ.

A. L. Melander, Pullman, Wash. (at the Bussey Institution, Forest Hills, Boston, Mass., until June), will determine *Empididæ* (Diptera) for the privilege of retaining desiderata.

SYRPHIDÆ.

A. L. Lovett, Corvallis, Oregon, will determine if duplicates are sent.

ITONIDIDÆ.

E. P. Felt, State Museum, Albany, N. Y., will classify provided the midges are new, from new localities or have been reared and food record is available.

MEGASTIGMUS.

C. R. Crosby, Cornell University, Ithaca, N. Y.

CHALCIDOIDEA.

A. A. Girault, Brisbane, Queensland, Australia, will classify.

BOMBIDÆ.

H. J. Franklin, East Wareham, Mass., will classify to limit of his spare time.

TENTHREDINIDÆ and UROCERIDÆ.

A. D. MacGillivray, 603 W. Michigan Ave., Urbana, Ill., will classify in so far as other work will permit for permission to retain types and specimens not present in collection.

APHIDIINÆ and OPIINÆ, sub-families of BRACONIDÆ.

A. B. Gahan, College Park, Md., will classify on condition that specimens may be retained if desired.

SPHECIDÆ, ELIDINÆ, APORINÆ, genus ICHNEUMON of N. E.

H. T. Fernald, Amherst, Mass., and assistants will classify.

ICHNEUMONIDÆ.

J. H. Merrill, Manhattan, Kansas, will classify, in so far as other work will permit *Rhyssides* of the *Ichneumonidæ*.

APOIDEA.

E. G. Titus, Logan, Utah. For permission to retain types and specimens not present in his collection.

Myron H. Swenk, Lincoln, Neb., will classify members of this group from Nebraska, and any North American member of the following genera—*Colletes*, *Nomada* and *Anthidium*.

NYMPHULINÆ.

Paul S. Welch, Manhattan, Kansas, will classify in so far as other work will permit, the family *Nymphulinae*.

MR. GLENN W. HERRICK: In regard to this report, I would like to state that if it is published together with the projects of the Bureau of Entomology, it will occupy about 46 printed pages which is nearly as many as are sometimes published in a single number of the JOURNAL OF ECONOMIC ENTOMOLOGY. The projects of the Bureau of Entomology have already been published by the Department of Agriculture and are available to the members of the Association.

After a general discussion of the feasibility of publishing the entire report in the JOURNAL, it was voted that the report as presented by the committee, which would occupy about 16 printed pages, be published in the JOURNAL, and that reference be made to the projects of the Bureau of Entomology so that the members desiring to secure printed copies of these projects could obtain them from the Department of Agriculture.

PRESIDENT H. T. FERNALD: I will now appoint the committees for the meeting:

COMMITTEE ON AUDITING: T. J. Headlee and Franklin Sherman, Jr.

COMMITTEE ON RESOLUTIONS: W. C. O'Kane, C. Gordon Hewitt and George A. Dean.

COMMITTEE ON NOMINATIONS: Wilmon Newell, A. L. Quaintance and C. P. Gillette.

The next order of business is the action on the proposed amendment to the by-laws.

MR. E. P. FELT: It if is in order, I would like to substitute in the proposed amendment the words "one dollar and a half" for "two dollars," for annual dues for active members. In explanation of this I will say that at the present time all members are paying $1.00 for the JOURNAL. Active Members pay $1.00 membership fee and Associate Members 50 cents. If we leave the by-law as it stands and continue the price of the JOURNAL to members at $1.00, the Active Members will receive their membership and the JOURNAL for $3.00; Associate Members for $2.00. If the subscription price of the JOURNAL is advanced 50 cents to both members and non-members, it will mean that Active Members will pay $1.50 a year for membership fee and $1.50 a year for the JOURNAL, while Associate Members will pay $1.00 for membership fee and $1.50 for the JOURNAL. This arrangement will result in placing the additional funds where they are most needed.

MR. T. J. HEADLEE: I would like to inquire whether this arrangement will provide ample funds for publication. I have felt that we need more money for publishing the JOURNAL and that we ought to take care of all papers that may be presented for publication and do it rather promptly. I would like to see the JOURNAL grow in size and serve a larger constituency.

SECRETARY A. F. BURGESS: In answer to the question raised, I will say that if this motion prevails and the change in subscription rate is made for the JOURNAL in accordance with the suggestion made by Mr. Felt, I think the stringency will be relieved and we will be in good financial condition. I believe we will be able to print a somewhat larger volume of matter in the JOURNAL but this will depend on how severely our foreign subscription list is curtailed.

It was voted to adopt the amendment suggested by Mr. Felt and Article 3, Section 1, of the By-laws was adopted so that it reads as follows:

"The annual dues of Active Members shall be $1.50 and the dues of Associate Members $1.00, which shall be payable in advance. No dues shall be payable from foreign members. Annual dues shall not include subscription to the JOURNAL OF ECONOMIC ENTOMOLOGY."

MR. E. P. FELT: In view of the fact that the Advisory Committee last year recommended an increase of 50 cents in the subscription price of the JOURNAL OF ECONOMIC ENTOMOLOGY, I move that this increase be adopted by the Association.

This motion was seconded and carried.

SECRETARY A. F. BURGESS: In the report of the Executive Committee a suggestion was made in regard to the possibility of holding a special meeting at San Francisco next year. It appears that the Executive Committee do not think it desirable to hold the annual winter meeting there. We have a large attendance at this meeting and it would seem desirable for a committee to be appointed to consider the matter and report at the last session on the advisability of holding a summer meeting at San Francisco. I would therefore move that a committee of three be appointed to consider this matter and report at the last session.

The motion was seconded and carried.

PRESIDENT H. T. FERNALD: I will appoint on this committee: W. E. Britton, R. A. Cooley, and E. G. Titus.

SECRETARY A. F. BURGESS: My attention has been called to the fact that Mr. H. E. Summers is not able to attend this meeting on account of illness. He is one of our representatives on the Council of the American Association for the Advancement of Science. I would therefore move that the Chair appoint a substitute to serve in Mr. Summers' absence.

The motion was carried and the President appointed Mr. J. G. Sanders to serve in this capacity.

MR. R. A. COOLEY: As has been previously stated, Mr. Summers is seriously ill and unable to attend the meeting. I move that the Chairman appoint a committee of three to draw up a suitable telegram to forward to him expressing the sympathy of the Association and our wish that he could have attended the meeting.

The motion was seconded and carried unanimously.

The President appointed on this committee: R. A. Cooley, Herbert Osborn and Wilmon Newell.

The final business session was held Thursday, December 31.

PRESIDENT H. T. FERNALD: We will now listen to the report of the Auditing Committee by T. J. Headlee.

December 31, 1914.

TO THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS:

Your auditing committee has examined the accounts of the Association, of the JOURNAL and of the Entomologists' Employment Bureau and finds them to be correct.

T. J. HEADLEE,
F. SHERMAN, JR.,
Auditors.

On motion, the report was adopted.

PRESIDENT H. T. FERNALD: We will now listen to the report of the Membership Committee by R. A. Cooley.

REPORT OF THE COMMITTEE ON MEMBERSHIP.

Your Committee on Membership Recommends

1. That the following named persons be elected to associate membership:

Walter S. Abbott, Vienna, Va.
Arthur J. Ackerman, Washington, D. C.
Harry W. Allen, Melrose Highlands, Mass.
Irving L. Bailey, Northboro, Mass.
Geo. W. Barber, Hyattsville, Md.
A. H. Beyer, Columbia, S. C.
M. W. Blackman, Syracuse, N. Y.
E. B. Blakeslee, Washington, D. C.
L. J. Bower, Salt Lake City, Utah.
Roy E. Campbell, Sacramento, Cal.
Thomas R. Chamberlin, Salt Lake City, Utah.
James W. Chapman, Forest Hills, Boston, Mass.
Robt. N. Chrystal, Ottawa, Canada.
C. R. Cleveland, Durham, N. H.
Geo. H. Corbett, London, England.
Harry F. Dietz, Indianapolis, Ind.
John E. Dudley, Jr., Vienna, Va.
M. W. Eddy, State College, Pa.
Wm. O. Ellis, Ithaca, N. Y.
W. T. Emery, Charlottesville, Va.
David E. Fink, Norfolk, Va.
R. J. Fiske, Washington, D. C.
F. H. Gates, Tempe, Ariz.
Hugh Glasgow, Geneva, N. Y.
John E. Graf, Whittier, Cal.
Ernst Hargreaves, So. Kensington, London, England.
Bartle T. Harvey, Colorado Springs, Colo.
Williard H. Hasey, Amherst, Mass.
Chas. C. Hill, Nashville, Tenn.
Harold R. Hogan, Logan, Utah.
A. H. Hollinger, Columbia, Mo.
N. F. Howard, Madison, Wis.
Ralph W. Howe, Tallulah, La.
John C. Hutson, Amherst, Mass.
J. L. King, Cleveland, Ohio.
Harry H. Knight, Ithaca, N. Y.
George H. Lamson, Jr., Storrs, Conn.
Walter H. Larrimer, Wellington, Kansas.
Edgar M. Ledyard, Berkeley, Cal.
Mortimer F. Leonard, Ithaca, N. Y.
Clifton W. Loveland, Providence, R. I.
James F. Martin, Amherst, Mass.
Frank L. McDonough, Batesburg, S. C.
Geo. B. Merrill, Aibonito, P. R.
Philip B. Miles, Salt Lake City, Utah.
Wm. Moore, St. Paul, Minn.
Wilfred A. Osgood, Durham, N. H.
C. M. Packard, Wellington, Kansas.
Frank C. Pellett, Atlantic, Iowa.
W. E. Pennington, Hagerstown, Md.
C. H. Richardson, New Brunswick, N. J.
Lawrence P. Rockwood, Salt Lake City, Utah.
Ernest E. Scholl, Austin, Texas.
E. W. Scott, Vienna, Va.
E. H. Seigler, Washington, D. C.
Sterling J. Snow, Salt Lake City, Utah.
E. H. Strickland, Ottawa, Canada.
Frank L. Thomas, Athol, Mass.
Chester F. Turner, Greenwood, Miss.
Jos. S. Wade, Wellington, Kansas.
Carrington B. Williams, Merton, Surrey, England.
Taylor S. Wilson, Wellington, Kansas.
Francis Windle, West Chester, Pa.
William C. Woods, Ithaca, N. Y.
Max P. Zappe, New Haven, Conn.

2. That the following named persons be transferred from Associate to Active Membership:

J. M. Aldrich, Bureau of Entomology, Lafayette, Ind.
E. W. Berger, University of Florida, Gainesville, Fla.
Lawson Caesar, Provincial Entomologist, Guelph, Ont., Canada.
H. E. Hodgkiss, N. Y. Experiment Station, Geneva, N. Y.
C. W. Howard, Minn. Exp. Sta., Univ. Farm, St. Paul, Minn.
P. H. Timberlake, Bureau of Entomology, Salt Lake City, Utah.
Geo. P. Weldon, California Board of Horticulture, Sacramento, Cal.

3. The Committee recommends that the following resignations be accepted:

A. B. Cordley, Corvallis, Oregon (Active).
J. C. Gifford, Cocoanut Grove, Fla. (Associate).
R. S. Mackintoch, St. Paul, Minn. (Associate).

4. The Committee recommends that the Secretary be instructed to notify five active members and six associate members who are in arrears for dues for two years, and two associate members who were elected last year and have not paid their first year's dues, that if such dues are not paid within three months their names will be dropped from the roll.

5. The Committee recommends that the Secretary be instructed to remit membership dues to Mr. Theodore Pergande, Washington, D. C., and retain his name on the roll.

6. The Committee desires to submit the following:

That the establishment of genuine departments of research by manufacturers of insecticides or by other similar organizations is to be highly commended, especially when the arrangements therefor take the form of endowment of research fellowships, thereby placing such work under the immediate direction of college or experiment station authorities; but in such cases, membership in this association, active or associate, should inevitably indicate disinterested and scientific investigation in applied entomology.

R. A. Cooley,
Wilmon Newell,
W. C. O'Kane,
Membership Committee.

On motion, the report was adopted.

President H. T. Fernald: We will now listen to the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Your Committee Submits the Following:

I. The Association desires to express to Dr. Henry Skinner, Dr. Philip Calvert and all other local entomologists, and to the University of Pennsylvania, its hearty gratitude for their cordial hospitality and for the admirable facilities provided by them for the association meetings. It desires to thank also the members of the Veterinary Faculty who have given their personal services at the sessions of the association.

II. The Association desires to place on record its deep appreciation of the work of The Imperial Bureau of Entomology of London, England, in the direction of disseminating through "The Review of Applied Entomology" information regarding the occurrence and control of insect pests in foreign countries, which information the members of the Association have found to be of very great value in their work on this continent.

III. The Association affirms its unalterable opposition to any tendency toward merging the identity of economic or applied entomology with that of plant pathology, under the term phytopathology, or other indirectly related but distinct branches of applied science; in the belief that such merging is without foundation in logic, utility or necessity.

W. C. O'Kane,
C. Gordon Hewitt,
Geo. A. Dean,
Committee.

By vote of the Association, the report was accepted.

PRESIDENT H. T. FERNALD: We will now listen to the Committee on Bibliography by E. P. Felt.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE BIBLIOGRAPHY OF AMERICAN ECONOMIC ENTOMOLOGY

Although the Committee was authorized by virtue of the action taken at the last meeting, to proceed with the preparation and publication of this bibliography, it was deemed wise to submit the project to the Federal authorities in a more formal manner. After some preliminary correspondence and investigation, a communication emphasizing the usefulness of the bibliography, outlining a plan for its preparation and strongly urging its issuance by the United States Department of Agriculture was forwarded to Dr. L. O. Howard, Chief of the Bureau of Entomology, who kindly transmitted it together with a recommendation that the plan as outlined by your Committee be adopted, to Dr. William A. Taylor, Chairman of the Committee on Publications of the Department of Agriculture. This latter Committee, under date of November 20 last, went on record as being fully impressed with the usefulness of this publication to working entomologists and as of the opinion that it should be published, but in view of the precedent which would be established by the resumption of its publication, could not recommend that it be published by the Department and the Committee therefore respectfully recommended that it be not approved for publication.

Your Committee, after consultation with Mr. Nathan Banks of the Federal Bureau of Entomology, recommends that this work take the form of an index of American literature for the decade ending with this year. A comprehensive and detailed plan has been adopted. It is estimated that the index will make a publication of from 100 to 125 pages which can be sold at approximately two dollars a copy.

Dr. L. O. Howard has kindly agreed to detail a man for the compilation of the index, and under the conditions obtaining, your Committee recommends that the preparation of the work be begun at once, and in the event of its being impossible to find any other satisfactory publishing agency, that the American Association of Economic Entomologists issue the index in accordance with the plan outlined in the report which was submitted and favorably acted upon at the Atlanta meeting.

Respectfully submitted,

E. P. FELT,
W. D. HINDS,
W. C. O'KANE,
W. E. BRITTON,
A. F. BURGESS,
Committee.

MR. E. P. FELT: I want to state that it has taken nearly a year to exhaust every reasonable resource to secure the Publication of the Bibliography by the United States Department of Agriculture. The vote taken at the last meeting provided that if other means could not be found for publishing the Bibliography that it be undertaken by the Association and the report that has just been presented, commits the Association to publish the Bibliography in case no other means of publication can be secured.

MR. WILMON NEWELL: I wish to say that I think the Association owes this Committee a debt of thanks for the effort which they have made to secure the preparation and publication of this Bibliography as it will be a great help to all entomologists.

MR. W. E. BRITTON: The plans suggested by the Committee differ slightly from that followed in preparing the Bibliographies that were published some years ago. The idea is to prepare it more as a bibliographical index. It will take up less space and the Committee believes be more useful to the entomologists than the former publications.

By vote of the Association, the report was adopted, and the Committee continued.

PRESIDENT H. T. FERNALD: Next in order is the nomination of JOURNAL officers by the Advisory Board.

MR. WILMON NEWELL: The Advisory Board of the JOURNAL OF ECONOMIC ENTOMOLOGY nominates the following officers for the ensuing year:

Editor, E. P. Felt.
Associate Editor, W. E. Britton.
Business Manager, A. F. Burgess.

By motion the report of the committee was adopted.

PRESIDENT H. T. FERNALD: We will now listen to the report of the Committee on Nominations.

MR. WILMON NEWELL: The Committee has found itself in a very perplexing situation, with a great deal of valuable material to choose from, so that its main regret is that several presidents could not be chosen and several additional vice-presidents. The Committee nominates for:

President, Glenn W. Herrick.
First Vice-President, R. A. Cooley.
Second Vice-President, W. E. Rumsey.
Third Vice-President, E. F. Phillips.
Secretary, A. F. Burgess.
Member of the Committee on Nomenclature, Herbert Osborn.
Member of the Committee on Entomological Investigations, E. G. Titus.
Member of the Committee on Membership, J. G. Sanders.
Councilors to the American Association for the Advancement of Science, S. A. Forbes and C. L. Marlatt.
Director of Employment Bureau, W. E. Hinds.
Members of Advisory Board of the JOURNAL OF ECONOMIC ENTOMOLOGY, F. M. Webster and P. J. Parrott.

By vote of the Association, the Chairman was instructed to cast a ballot for the officers nominated by the Committee. A ballot was cast and the above-mentioned officers were declared elected.

PRESIDENT H. T. FERNALD: Is there any miscellaneous business to be acted upon at this time?

MR. T. J. HEADLEE: I have been interested in examining the list of Associate and Active members and it seems to me that there are some men on our Associate list who should be promoted to Active Membership, and I would be very glad to see the Committee next year adopt the policy of promoting more Associate Members to the Active list.

SECRETARY A. F. BURGESS: I would like to call attention to the report of the Membership Committee which was adopted by the Association last year. The first section of that report reads as follows:

"that in the case of Active members desiring to nominate Associate members for Active membership, they shall file such nominations with the Chairman of the Committee on Membership at least three months prior to the annual meeting. Such nominations shall be accompanied by full information concerning the nominees' publications and other qualifications."

I wonder how many such statements were filed with the Committee on Membership three months prior to the time of this meeting. I am not speaking for the Committee on Membership but from the relations which I have had with the members, I know that they have an immense amount of work to do. They can do it more thoroughly and better if they have ample time. I have read this section of the report of last year while many members are present so that during the coming year those who know of Associate members who should be promoted, will take the matter up in time and give the Membership Committee a fair chance to consider each case.

MR. R. A. COOLEY: I have been on the Membership Committee for three years and I know that it is the wish of that Committee to follow strictly the desires of the Association in regard to recommendations concerning membership. It has come to my attention a number of times that members of the Association were not fully informed as to the limits set by the constitution on Active Membership, and also of the resolutions which have been adopted by the Association from time to time for the guidance of the Membership Committee. The Membership Committee has a difficult task to perform but I know it will welcome suggestions from the members of the Association.

PRESIDENT H. T. FERNALD: The Chairman has found it somewhat unpleasant on his part to be obliged to enforce the time limit on members who have presented papers. Our rules limit the time for a paper to 15 minutes and it is the custom to consider the amount of time requested by a member when presenting his title as the maximum that he will need. If the rules had not been rigidly enforced at this

meeting, I fear we would not have been able to complete our program. I would suggest therefore that it will make it much easier for the presiding officer next year if members will estimate more closely the amount of time which they need to present their papers. I would also call attention to the reference already made in the report of the Executive Committee to the preparation of an official seal for the Association. I am sure the new officers will be very glad to receive suggestions in regard to a proper design for a seal.

MR. R. A. COOLEY: The Membership Committee have found it difficult to consult the constitution and by-laws of the Association owing to the fact that a number of amendments have been made from time to time since the constitution was printed. I would therefore move that the Secretary be authorized to have the constitution and by-laws printed in the JOURNAL during the coming year.

By vote of the Association, the motion was carried and the Secretary so instructed.

Mr. R. A. COOLEY: I wish to report that the committee appointed to send a telegram to Mr. Summers has done so, extending the greetings of the Association and its wishes for his speedy recovery.

MR. C. GORDON HEWITT: I move that the Association extend a very hearty vote of thanks to our President and Secretary, who have carried on this meeting with such expedition and in such a satisfactory manner. We all appreciate the difficulties which the President mentioned in regard to keeping us within time limits, and I am sure that his efforts have been very satisfactory and that we have not suffered in any degree from the President's very necessary rulings.

By vote of the Association the motion was adopted.

PRESIDENT H. T. FERNALD: I am sure that the President and Secretary both appreciate the kind feelings which you have indicated in this way.

We will now listen to the report of the committee on the next meeting by W. E. Britton.

REPORT OF COMMITTEE ON MEETINGS

Your committee has conferred with a number of members present and all agree that a meeting next year in California should not in any way take the place of our regular winter meeting. Undoubtedly an extra summer meeting for field excursions, papers and discussions would be desirable; it would give western entomologists a meeting in their part of the country; it would afford an opportunity for eastern men to visit the Pacific Coast, survey the conditions there and at the same time meet with their brother workers; a general round-up for interchange of thought and opinion would surely be a benefit to those in attendance and to economic entomology in America.

Your committee, therefore, recommends that the Executive Committee of this Association be authorized to arrange such a meeting for the summer of 1915; that

the Association hold its next annual meeting in affiliation with the American Association for the advancement of science, and that all arrangements for this meeting be referred to the Executive Committee with power to act.

W. E. Britton,
R. A. Cooley,
E. G. Titus,
Committee.

By a vote of the Association, the report was accepted and recommendations adopted.

Mr. E. G. Titus: Inasmuch as there will be a western meeting next summer, I wish in behalf of the entomologists of Utah to invite any members going west to stop at Salt Lake City. If you will advise us when you are coming, we will endeavor to meet you. There are a number of entomologists in that city and they will all be glad to receive you.

Mr. R. A. Cooley: I wish to say that in going to California, you can pass through Montana by travelling on the Northern Pacific Railroad. We would certainly be delighted to receive you in Montana and show you every courtesy.

Mr. C. Gordon Hewitt: I should like to add to the remarks of the last speakers that the Canadian Pacific also offers a delightful and interesting route to the West. We would be pleased to entertain any members who may be going that way.

Mr. George A. Dean: Inasmuch as so many have given glowing invitations, I would like to call attention to the fact that we in Kansas are right in the center of the United States, and that it is a good place to break the long journey. We can't give you anything to drink out there except water, but we can assure you of a hearty welcome at Manhattan, right on the main line of the Rock Island and the Union Pacific.

Mr. Wilmon Newell: In connection with the invitations already presented, permit me to say that there are some people of good taste and refinement that occasionally take the southern route to California, and I would go farther and in the language of a New Orleans restaurant, would say that "If you would see and be seen by people of prominence, take the southern route," and we would be more than glad to welcome you and give you consideration for entomological and gastronomical things. (Applause.)

President H. T. Fernald: If there is no other business, I hereby declare the twenty-seventh annual meeting of the Association adjourned.

PART II PAPERS AND DISCUSSIONS

PRESIDENT H. T. FERNALD: I will ask first Vice-president Herrick to take the chair.

VICE-PRESIDENT HERRICK: We will listen to the annual address of the President.

SOME PRESENT NEEDS IN ECONOMIC ENTOMOLOGY

By H. T. FERNALD, *Amherst, Mass.*

The wonderful progress of economic entomology during the past half century in this country, and more recently in other lands, has to a large extent, after all, been pioneer work and the farther exploration has advanced, the broader the territory has been found to be. Who foresaw at the time of Dr. Riley's first presidential address in 1890, that twenty years later entomologists would be studying pellagra, typhoid, and other diseases to determine the relation insects bear to them, or that the importation of parasites and the study of insect diseases would perhaps lead to successful methods of control? A few of those having the broadest vision perhaps, but only a few. Today if we examine the fields of investigation awaiting the worker no limits seem in sight, and each year to come is liable to bring with it the first steps in paths hitherto untrodden.

Stated briefly, the present needs of the economic entomologist appear to group themselves under two main heads. These are: first, more complete and accurate investigation of subjects which have already been more or less studied; and second, the investigation of new territory; while correlated with both are certain needs which are necessary to the successful prosecution of either. To consider some of the subjects under these heads is my purpose today.

It has been said that we do not know everything which should be known about even one insect. I well remember that when the book on the gypsy moth appeared in 1896 someone remarked—I think at one of these meetings—that it was the nearest to a monograph of an insect which had ever appeared. But if we examine the wonderful contributions to the life, habits, enemies and methods of control of this pest which have since appeared, it becomes at once evident how far it fell short of being what it was supposed to be. Since the appearance of that book the labors of State and United States workers have probably doubled our knowledge of this insect, and still there is much more awaiting discovery.

If this be true, how much more is it true of many others of our most common pests. How much uncertainty is to be found with reference to the fall brood of the army worm—what method of spraying is the best to use for the codling moth—how may we best attack the species of white grub, wire worms, etc.? But it is unnecessary to multiply examples. They will occur in too large numbers to all.

First, then, let me make a plea for more exhaustive studies of the life histories of even our most common pests. Some small, apparently unimportant point, perhaps already partly revealed, may on investigation prove the key to a new and successful method of control or at least solve some perplexing point. Thus the discovery of aerostatic hairs in young gypsy moth larvæ has provided a possible explanation for the appearance of colonies in unexpected places and has pointed out the necessity for close watching far beyond limits of continuous distribution, to discover and suppress such colonies before they have become so large as to make this impossible.

After all, we have thus far been merely skimming the surface in this part of our work and among other things not the least important is a thorough knowledge of the lives of our insect foes.

What has just been said also holds good for another class of insects—those which though ordinarily not injurious may at some time become so. When the saddled prominent (*Heterocampa guttivitta* Walker) suddenly appeared in destructive abundance a few years ago, the entomological workers in the region attacked were seriously handicapped by the fact that practically no information about this insect was available, and their time was taken, less by giving advice what treatment to use, than in finding this out for themselves. Of course, this could not have been avoided, but nevertheless careful studies of insects not ordinarily destructive may at almost any time become of extreme value.

Another subject which needs much more investigation, is that of insecticides. Just as quinine was empirically known as a treatment for malaria long before the cause of the disease was known, so are a number of insecticides used in treatment, with no definite knowlege as to the nature of their action or of their effect on plants. A thorough study of various materials, both among stomach poisons and contact insecticides, to determine their effect on insects, the way in which they may be best applied, their action if any, on plant tissue, the range limits of safety in strength for application, and variation in any of these points under varying conditions of light, temperature, humidity and other conditions, should be made with care if we are to learn how and when to apply insecticides with entire confidence in the results. New stomach poisons are undoubtedly awaiting discovery, yet until within the last

half dozen years the possibility that anything but arsenic could be used does not seem to have occurred to most workers. The work of Maxwell-Lefroy along this line in India deserves mention here because of its pioneer nature.

When on the same day two peach orchards, one in Northern Ohio and the other in Virginia, are sprayed with the same material at the same strength, and apparently under practically the same conditions, and one orchard is severely injured while the other escapes, it is time for a critical study of all the factors concerned in spraying.

And here I must make a statement which will seem very academic in its nature. In research experimentation in almost every case a large number of factors are involved. Frequently these are light, temperature, humidity, composition and variations in composition of the material used, time of year, etc. If we are to obtain positive and conclusive results from our experiments we must take into account every factor which may possibly be concerned, and run a series of experiments in which only one factor shall vary, the others remaining fixed. This, of course, means a complete series for each factor involved, in combination with every variation of every other factor. Such experiments take time—often many years—to produce complete results, but the necessity for conducting them in this way if the conclusions reached are to be relied upon, should be self-evident. Yet a careful analysis of many of the experiments, the results of which have been published during the last decade, shows that in some cases three, four or even more of the factors which might influence the results have been allowed to vary at the same time. Under such conditions as these I claim that the principle just advanced, even though acknowledgedly academic, is being so largely ignored that attention should be called to it, and that work done without due care should receive only such fractional credit as it deserves, without acceptance as a final dictum.

Some of those present today listened last year to a magnificent presentation of the methods used in the investigation of pellagra in the South. Several afterwards remarked that such thoroughly systematized and comprehensive studies could only be carried out with the resources and staff which the Government alone could supply. But if this should be true (and I doubt it), this is no reason why such work as is attempted should not be prosecuted in accord with the simplest principles of inductive logic, as far as it goes, resulting at least in reliable records of the ground actually covered.

The "bug versus bug" doctrine which has been so actively promulgated in various parts of the country is a most attractive one. It appeals to the legislator, to the farmer, and to the business man as a natural and logical method for the control of our increasing insect

enemies, and it is probable that appropriations for investigations in this subject can be more easily obtained than for any other form of entomological work. Much has been done along this line, particularly by the United States Department of Agriculture, and many striking results have been obtained. If, however, a supposed parasite when imported and liberated should prove to be a secondary parasite, much of the benefit of the entire work might be lost, thus emphasizing what has already been said as to the necessity of a thorough knowledge of the life history and habits of every insect. The introduction of parasites will undoubtedly prove an extremely important part of the work in economic entomology in the future, but it must be conducted only by the most competent persons and after a thorough knowledge as to what will happen thereafter in each case.

An examination of the list of subjects under investigation, given in the JOURNAL OF ECONOMIC ENTOMOLOGY, suggests one or two points of interest to consider for a moment. One of these is—How many subjects can be completely worked out by one man who feels the pressure for publication behind him all the time? It seems likely that this pressure must often result in premature and imperfect publications, liable to give misleading impressions. A few years ago, at one Experiment Station at least, the director would sometimes inquire whether the entomologist of that station ever intended to get out a bulletin. Under such conditions one cannot expect the best work, but instead the production of hastily prepared and fragmentary papers. Another thought developed by an examination of the list is that to make satisfactory progress on all the projects named, in same cases, the investigator must be working twenty-four hours per day, seven days each week. Such pressure as this can only lead to an impairing of the quality of the work done, and it would seem wiser to attempt fewer projects and thus obtain more complete and satisfactory results.

Many other topics might be legitimately touched upon here, but time will not permit. I therefore turn to the second division of my subject; viz., the investigation of new territory.

Under this head there are undoubtedly many surprises in store for us. The gates to several new fields of entomological knowledge have recently been discovered and are now standing ajar, giving us glimpses of what may come. One of these is the field of medical entomology, and the presidential address before this Association two years ago ably pointed out the progress which has already been made in that line.

To mention some other topics which promise rich returns to the investigator is a dangerous task, for in the time available it is impossible to even name them all, and to touch on only a few would seem

to be making invidious distinctions. Yet to everyone, certain subjects appeal more strongly than others, and on this basis of personal interest alone, a few which have for one reason or another appealed strongly to the speaker, may be referred to briefly.

The researches of Bachmetjew upon the temperature relations in insects, followed by those of others who have applied his discoveries to the preservation of life during the winter—investigations in which Sanderson and others have been active in this country—are full of significance. Closely connected to this have been the studies of the relation of temperature to development, one paper on which was presented at the last meeting of this Association. It is my belief that work along these lines has only just been begun, and that the results will prove of great importance, not only to pure science but to economic entomology.

Another field which promises to contain much of great value is that of the relation of food to reproductive activity and to longevity. Though thus far investigated mainly with reference to parasites, it would seem to be of importance everywhere, and the subject deserves far more extended exploration.

The subject insecticides has already been referred to, but how little we really know as to the way in which some of them actually kill insects has been most interestingly shown by Shafer. More work in this field is waiting, and results of an importance which cannot yet be estimated are sure to come.

Whether it is possible by methods of plant breeding to produce varieties having greater freedom from the attacks of insects than those now in use, is a field which so far as I know has not yet even been seriously considered. The only cases which occur to me are the recommendation to select varieties of wheat which "tiller" freely, as a means of saving wheat fields liable to attack by the Hessian Fly, and the unfortunate one where two New Jersey nurseries apparently spread the San José Scale over the country in their attempts to find a Curculio-proof plum, and even those do not come strictly under the head of actual plant breeding. Whether this field will prove productive no one can tell at present, and actual exploration will be necessary to determine whether it is to be of any value.

The sensation produced by the appearance of a bulletin a few years ago upon the arsenical poisoning of fruit trees by spraying is still well remembered by us all. Here was a new field for exploration and a number of workers have now attacked this subject. Whatever the final conclusions reached may be, more information along this line is necessary, and it may be permissible to suggest that a knowledge of what "thou shalt not" do in entomology is ofttimes as valuable as knowledge in its positive form.

Insect outbreaks and their causes are as yet entirely without explanation except in such general terms as to leave us as uncertain when to expect them and how to prevent or prepare to meet them as before. We guess they may be due to climatic conditions beyond our control or perhaps to an unusual absence of the natural enemies of the insects concerned. I find practically no evidence on the subject, however, and if climatic conditions are involved we lack any knowledge as to what these are. We need pioneers to explore this field and can only hope that some day, even if they cannot tell us how to prevent the outbreaks, they may discover the principles involved and be able to warn us of those soon to come. When the entomologist can publish a notice that the army worm, for example, will appear in destructive abundance the coming summer, based on anything like definite certainty, we may consider ourselves as having made a long forward step in the progress of the science to which we are devoting our lives. Whether this can ever become possible is after all aside from the point. We must explore the field and find out. Personally, taking the progress of entomology in the past as a criterion, I believe the time will come when the causes of outbreaks will be thoroughly understood and their times predicted with nearly as great accuracy as is now done for the weather.

The possibility of the successful introduction and spread of insect diseases through the agency of man has been given some attention for quite a long time. Thus far the results can hardly be called encouraging, for though disease is often very effective, man's relation to it appears to have been quite unimportant, the factors determining success seemingly having been beyond his control. Whether this will always be the case, or whether the introduction of new methods of work and distribution may place this field in the list of those which can be profitably tilled, can only be learned by further research. It is to be hoped, therefore, that workers in this line may continue their investigations until its possibilities have been fully demonstrated.

Factors which influence the distribution of animals and plants have been given considerable attention by zoölogists and botanists, at least since the appearance of Wallace's two classic volumes on "The Geographical Distribution of Animals." In all the literature on this subject, however, little consideration has been given to insects. Passing references, allusions to the presence of different forms in the different life zones, and general statements make up the bulk of published information about insects in this field. So far as I can learn, no argument bearing on crop raising has ever been provided from this source of information. The publications of the Bureau of Biological Survey list the mammals, birds and other vertebrates, and the plants of the

zones; and shells have occasionally been studied from this standpoint. Yet particularly within certain areas insects are of great assistance in indicating zone limits, and the only data available for study are faunal lists, in which too often the exact localities of capture and the elevation are unrecorded. We generally even lack a knowledge which zone a given insect particularly belongs to.

Of course, many insects are so hardy and have such powers of flight that they cannot be taken into consideration as evidence. Many others, however, provide us with important information if we only know how to use it.

It may seem almost outside the realm of entomology or at least economic entomology to be concerned with distribution except in the most general way, and it is true that in a number of states—perhaps a great many—all kinds of insects present at all are liable to be found anywhere in the state where their necessary food occurs. In many other states, however, this is far from being the case and the determination of the zonal limits in those states as indicated by the insects and supported by other animals and by plants, can lead to modifications in the crops raised, with direct benefit to agriculture.

To illustrate this by the conditions found in Massachusetts: This state is generally considered as being mainly in the Transition Zone, barely touched at one or two points on the south by the upper Austral and on the north by the Boreal. A study of distribution shows, however, that the entire southeastern portion of the state, the Connecticut Valley and two other inlets from the south are inhabited by upper Austral forms to a greater or less degree, while quite an area in the western end of the state and spots near its northern boundary have many Boreal forms.

Knowledge of this of itself, meant but little at first. But when the elm-leaf beetle had become well established, it was finally discovered that while it was a serious pest in the upper Austral sections and frequently of some importance in the Transition Zone, it was never sufficiently destructive in the Boreal areas to make treatment necessary.

The elms of Massachusetts are one of her chief attractions, shading her streets by their high arches, and growing to perfection. Their value has in some cases been fixed at five hundred dollars per tree, and nearly every town has thousands of them. Spraying for the elm-leaf beetle is almost universal in the state and an expenditure of from five hundred to twenty-five hundred dollars for this purpose each year is anticipated as a part of almost every town financial budget. Accordingly, when it was discovered that elms growing in the Boreal region need not be sprayed, thus saving that much expenditure to the towns concerned, the value of a knowledge of the zonal areas at once assumed an economic importance heretofore unrecognized.

But another surprise was yet in store. An inquiry from the shore in Southeastern Massachusetts about a burrowing insect attacking persons out berrying in midsummer led to the discovery that this trouble was caused by the larva of a mite, and attention was at once directed to the southern "jigger" and an attempt was made to ascertain the northern distribution limits of this Acarid. The data were decidedly meagre, but the southern shore of Lake Erie and somewhere along the New Jersey coast were the most northern points from which reports of attacks either by the jigger or some other similarly acting pest were received. A scrutiny of records of mammals, birds, plants, etc., captured in Southeastern Massachusetts was then undertaken to see if it would throw any light upon the conditions existing in that region, and as no collections of insects of any extent seemed to have been made there, it was planned to take up the subject by spending time in that territory for the distinct purpose of collecting.

The results thus far have been most interesting though not entirely conclusive. Numerous mammals, birds and reptiles abundant farther south but not found north of New York or even Central New Jersey occur here. Numerous southern plants not recorded from elsewhere in New England are found on Nantucket where the flora has received particular attention, and some are present on the mainland. The insect collections support the view that this part of the state has a decidedly southern aspect, and taken all together we find a strip here that is not only upper Austral but to some extent, lower Austral as well. Meteorological observations show that this portion of the state in many regards has summers comparable with those much farther south and that the winters are usually mild as compared with those only a few miles farther north, and some theory to explain these facts is, of course, in order.

An examination of the records of the United States Fish Commission, which has for many years maintained a station at Woods Hole in this district has thrown some light on this subject. According to most of our maps the Gulf Stream on its way north apparently leaves any close proximity to our coast about at Cape Hatteras, swinging strongly to the northeast. The observations of the United States Coast Survey and Fish Commission, however, show that this is not entirely correct. A study of water temperatures during a series of years indicates that the real western margin of the Gulf Stream is found not very far east of Nantucket, and also that it varies, in some years being much closer to the land than at others. Occasionally, indeed, it comes so near the land that southern floating animals such as the Portuguese Man-of-War are swept up Vineyard Sound, inside the islands, in the current, and other forms belonging much farther south may be brought in the same way.

It has been suggested that the strength and direction of the wind influence the fluctuation of the Gulf Stream, perhaps begun by an unusual strength of the southeast trade winds and their extension farther north than is usually the case. Whatever the cause may be, however, the fact remains that the Gulf Stream swings in and out, its western edge sometimes remaining near the coast for a number of years, and with this demonstrated we have a satisfactory basis for the theory that southern forms may from time to time be brought to the southeastern shores of Massachusetts in this current, thus accounting for their occurrence there. It also offers an explanation for their continued presence, for the near proximity of such a large body of warm water must naturally affect the climate of that part of the state, making it inhabitable for forms normally found much farther south.

Occasionally a severe winter, particularly when the oscillation of the Gulf Stream is eastward, must result in the destruction of many of these transplanted forms, but with the return of the Stream to its more westerly course the reëstablishment of such animals and plants as may be caught in this current and can survive the journey is likely to occur.

The practical application of these facts to agriculture comes in their bearing on the possibility of raising southern crops in the territory affected. With a summer thus lengthened, and warmer than in most of the state, the possibility of making use of these conditions to advantage presents itself, limited only by the nature of the soil and factors which aside from seasonal features require consideration.

A little work along this line has already been begun in an experimental way, and it has been found that sweet potatoes and peanuts can be raised on Cape Cod under the usual conditions there. Cotton might possibly be grown also, if the proper soil conditions could be found, but this has not been tried. The greatest value thus far resulting from the facts just presented is the realization that crops can be planted late, to supply the markets after the main season is over, without danger of their loss by early frost, and this is now being taken advantage of.

The conditions in Massachusetts have been dwelt upon at some length, because of familiarity with them; that life zones play a part, to some extent at least, in many other states is certain. The possibility of taking advantage of them is something which deserves consideration, and even if no direct economic result is obtained, a knowledge of the distribution of insects in the zones will be a great and useful addition to entomology as a whole.

Another present need of economic entomologists is a better knowledge of foreign insects. Modern transportation facilities have ren-

dered easy the introduction of the pests of other countries, and in spite of all the laws, supervisory boards and inspectors now actively at work, some of these pests at least are sure to slip in. To recognize these in their different stages and to know what steps to take for their control as soon as they appear are points becoming more important each day, and any information which can be obtained on this subject would be welcomed by every entomologist. It is to be hoped that specialists connected with the Department of Agriculture may before long find it possible to prepare a bulletin in which the worst pests of foreign lands liable to reach and establish themselves here may be dealt with in detail, and that illustrations of the different stages of these insects may be given to aid in their recognition.

The nun moth, to take a particular case, is regarded as a serious pest in Europe. When we consider the often difficult conditions under which our inspectors of imported nursery stock work: in places poorly lighted, or as night comes on; with work enough often for three men, and only one to do it; with plants so dense that it is often impossible to get at every part; with earth at the roots, which should not be removed: and too often also, with only a most general idea of what may possibly be found; under such conditions as these, we can hardly be surprised if some day the nun moth may escape observation, and before discovery, establish itself in this country, and what is true of this insect is true of many others. Sooner or later then, the American entomologist must to some degree become a world entomologist and the sooner his training covers this broader field, the better, for in the opinion of the speaker, the time must ultimately come when in spite of laws and inspections the pests of one country will become the pests of all others except where climate, lack of food, or other natural conditions operate to prevent it.

Whatever line the economic entomologist may pursue, it is evident that to reach the best results, more thorough work will be required. The study of a pest without finding a satisfactory method of control means either that the investigation was not complete, or else that our knowledge of control methods is defective. Frequently both are true. To obtain results of the kind desired, more careful and thorough—I may say monographic—work will be necessary. For this a natural aptitude, coupled with thorough training are essential to the worker, and in the long run the great results will be mainly achieved by men of this type. Persistence, attention to details, not knowing when at any moment one of the smallest of these may provide a solution of the problem, an active, inductive mind, and extreme patience in working are factors essential to success.

But whatever the work may be, when success has been attained,

the problem of publication almost always presents itself as the last and often by no means the easiest one to solve. Brief papers are fairly well taken care of now by the various entomological journals, but the best work of the future is liable to become more and more comprehensive in its nature, and for contributions of this kind there are few opportunities for publication. One crying need in economic entomology at the present time is a place where the results of extended research can be published in full. An entomological Journal on the plan of the *Journal of Morphology* would greatly help in relieving this condition, though like that journal it is probable that within a short time papers might be delayed a year or more before publication. Even then, such a magazine would be of great assistance, and with sufficient funds to permit of the frequent publications of numbers, the problem would be solved at least for the most part. Such a publication, however, would probably never pay for its cost and the problem of publication accordingly becomes one of financing. Where is the man who will establish a publication fund, or the organized body which will make a supporting grant, for this purpose? When this question has been answered one of the most important present problems of economic entomology will have been solved.

VICE-PRESIDENT HERRICK: We have listened to this exceedingly suggestive address by the President. It is customary to defer discussion until the next session.

PRESIDENT H. T. FERNALD: The first paper on the program will be presented by T. J. Headlee.

THE CONTROL OF MOSQUITOES IN A LIMITED LOCALITY

By THOMAS J. HEADLEE, PH.D., *New Brunswick, N. J.*

INTRODUCTION

Adequate consideration of the problem of controlling mosquitoes in a limited locality involves a careful study of the nature of the breeding places within the proposed limits and an almost equally careful examination of the environs of the area to be protected. Conditions may be found within the area or in the territory surrounding it which will prevent successful work except at prohibitive cost. Any person, corporation, or municipality planning to take up anti-mosquito work should, therefore, have the territory to be protected and its environs carefully studied to see whether effective work can be done at a figure which he or it is willing to pay.

For the past three years two counties in New Jersey have been trying to control the mosquitoes within their limits. For the past two years two other counties have been engaged in similar work. Three of these counties—two of which have been working three, and one, two years—are sufficiently alike in their internal and external conditions to render a comparison of their methods and results of value. For purposes of discussion, they will be referred to as counties A, B, and C.

Description of the Counties

County A consists of two rather narrow parallel ridges of high ground that run northeastward—one on each side of the Hackensack River Valley. The eastern ridge extends southwestward along the head of Newark Bay to the Kill-von-Kull; and New York Bay and the Hudson River wash its eastern base line. The ridges are rather well drained but include between them more than 11,000 acres of salt marsh, nearly all of which, before ditching, bred salt marsh mosquitoes at some time in the season. The entire area of the county amounts to about 60.48 square miles of which 17.29 are tidal marsh and sparsely inhabited. A population of 572,172 people is concentrated on these two ridges with the great majority on the eastern one. To the north of this county lie the 8,378 acres of salt marsh of the upper course of the Hackensack River and its tributaries. To the southwest lie the 8,000 acres of salt marsh along the northern, western and southern shores of Newark Bay and to the southward the salt marshes of Staten Island.

County B consists of a greatly rolling surface rising from the salt marsh on the northern and western sides of Newark Bay. As one proceeds northwestward, the ground rises and becomes rougher until the hills merge into low mountains. The 554,069 people are largely concentrated in the southeastern section in the city of Newark, but to the north and westward of Newark the area is also thickly populated. Of the 129.72 square miles of surface, a little more than 7 are salt marsh. All of this salt marsh is found along the eastern and northeastern boundary between the high land and Newark Bay. County B lies within reach of the 19,846 acres of Hackensack Valley salt marsh, the marshes of Staten Island, and the 4,000 acres of County C.

County C surface is much like that of County B but a large portion is level lying. It begins as a 4,000 acre salt marsh north and westward of Newark Bay and the Arthur Kill, and rises gently to the low mountains along its western and northern edge. Its entire surface includes 104.94 square miles. The population is generally distributed, the largest city, Elizabeth, showing in 1912 a population of 78,500.

To a certain extent this county lies within reach of the Hackensack Valley, Staten Island, and Newark Bay salt marshes.

At this point it should be said that, with the exception of the 8,378 acres of salt marsh along the upper courses of the Hackensack, an effort has been made to drain all these salt marshes, and that only to a minor extent do the mosquitoes bred on this exception trouble counties A, B and C.

The Work of Control

Inasmuch as the plan of organizing a mosquito fighting machine has already been briefly described to this Association, it is sufficient to say that the work of control naturally divides into administration (the management of the work), inspection (the finding of the breeding places), and elimination (the destruction of breeding places). Necessary to all three phases is the equipment (tools and apparatus), and education (acquainting the people with the nature and progress of the work).

Administration

Under the head of administration is included the necessary expenses of the commissioners, and the salary and expenses of the chief inspector and of his deputies, and of the necessary clerical force. The expenses of the commissioners are small or none. The number of deputies and the size of the clerical force are variable. County A has no deputies and has one person to do all the clerical work. County B has two deputies, one clerk and one stenographer. County C has one deputy and one stenographer. The variation in percentage of the total expenditure devoted to administration is, however, small—County A spending 13 per cent and 14 per cent in 1913 and 1914 respectively. County B, 12 per cent, 12 per cent and 14 per cent in 1912, 1913 and 1914; and County C, 9 per cent, 13 per cent and 17 per cent in 1912, 1913 and 1914.

Inspection

Inspection includes all work done to find the breeding places of the mosquitoes, and means on the upland the complete examination of the entire territory approximately every two weeks throughout the four to five months of the breeding season. On the salt marsh it usually means the complete examination of the marsh following each flooding by extra high tide or heavy rainfall.

These examinations are made in different ways. County A has made a practice of assigning a district to one inspector and giving him some laborers. County B in 1912 and 1913 assigned a district to each

man and made him responsible for its condition. In 1914, however, a district was covered by a squad and the squads shifted from one district to another. County C has adhered to the plan of assigning a certain territory to one inspector and holding him responsible for its condition.

It should be said that the inspector is not a permanent employee and that his tenure begins and ends with the mosquito breeding season. Two to four inspectors are usually kept on throughout the year for the purpose of doing ditching and filling work and to serve as teachers for the inexperienced men of the larger force.

Of the total expenditures the percentage devoted to inspection shows considerable variation. In County A 18 per cent and 20 per cent were devoted to inspection in 1913 and 1914 respectively; in County B 45 per cent, 31 per cent, 24 per cent in 1912, 1913 and 1914; in County C 24 per cent, 28 per cent and 33 per cent in 1912, 1913 and 1914.

Elimination

Under the term elimination is included all those operations of draining, filling, oiling, cleaning and stocking with fish that are necessary to do away with mosquito breeding places. All the small jobs are attended to by the inspectors as they go about their duties, and a very considerable part of this work is thus cared for under the head of inspection. The treatment of the larger places is a matter for laborers employed by the commissions or for doing under contract.

A large share of the funds go to this work. In County A 63 per cent and 61 per cent were used in 1913 and 1914; in County B 33 per cent, 51 per cent and 54 per cent in 1912, 1913 and 1914; in County C 59 per cent, 46 per cent and 40 per cent in 1912, 1913 and 1914. Of the total expenditures for elimination only a part was used on the upland, the rest being expended on the salt marsh. Of the expenditure for all purposes, in County A 31 per cent and 32 per cent were used for elimination of upland breeding places in 1913 and 1914 respectively; in County B 19 per cent, 21 per cent and 23 per cent were used in 1912, 1913 and 1914; while in County C 32 per cent, 31 per cent and 21 per cent were employed in 1912, 1913 and 1914.

Thus it appears that about half of all expenditure is devoted to elimination of large breeding places, and that of this amount about one-half goes to the upland.

Equipment

Equipment covers spades, hooks, rubber boots, bicycles, motorcycles, automobiles, surveying instruments, tapes, chains, office furni-

ture, filing cases and typewriters. As might be expected, there is much variation in the amount and kind of equipment used by the different organizations.

The percentages of the total expenditures for equipment run as follows: County A, 5 per cent and 4 per cent in 1913 and 1914; County B, 9 per cent, 5 per cent and 7 per cent in 1912, 1913 and 1914; County C, 6 per cent, 6 per cent and 6 per cent in 1912, 1913 and 1914.

Education

Under the head of education is included the publication and distribution of educational pamphlets, the furnishing of newspaper and magazine articles, the giving of lectures, and the preparation and placing of exhibits.

With the exception of that used in publishing the annual reports, very little money has been expended on education. This is not due to little educational work having been done but to the fact that the administrative officers and commissioners have furnished much of the matter and the publishers have printed it without cost to the commission. In nearly all cases, however, it has been found advisable to prepare and distribute a simple statement of mosquito life history and control methods.

It should, also, be said that one of the most effective methods of education is found in the prompt and efficient prosecution of persons who insist on maintaining mosquito breeding nuisances.

Salt Marsh

From the time that Dr. John B. Smith completed his proof of salt marsh mosquito migration, it has been evident to all students of mosquito elimination that in every area within reach of a breeding salt marsh, mosquito control depends on the prevention of breeding on that marsh. This principle holds good for counties A, B and C now just as it did before drainage.

Drainage has not eliminated all the breeding but has cut it to a point where it can be controlled. In fact, there are certain parts of the salt marshes of Newark Bay and the Hackensack River where the ordinary ditching will not do the work of elimination even to this extent—where it is necessary to dike and tide-gate and in a few instances to pump.

That the commissions realize the importance of the salt marsh is indicated by the percentage of the total expenditures devoted to salt marsh work. In County A, 32 per cent and 29 per cent were used in 1913 and 1914; in County B, 14 per cent, 30 per cent and 31 per cent

in 1912, 1913 and 1914; in County C, 27 per cent, 15 per cent and 19 per cent in 1912, 1913 and 1914. As a matter of fact, the writer believes that the future will be likely to see a larger percentage go to the salt marsh instead of a smaller. The control of salt marsh breeding will continue to be a very important phase of mosquito work in counties A, B and C until the marshes are filled or brought under cultivation.

A Better Method of Determining the Efficiency of the Work

The writer believes that the greatest weakness of the mosquito control work, as he has seen it, lies in the fact that the mosquito fighting organizations are inclined to depend upon citizen complaints and a little scattering collection of mosquitoes on the wing to determine whether the work is efficient. The work of the past summer in collecting mosquitoes on the wing, in which Counties B and C coöperated so fully, clearly showed that between the absence of mosquitoes and citizen complaints there exists a considerable fauna of mosquitoes and that so long as this fauna does not increase beyond a certain point the householder does not recognize its presence. These collections further showed that regular, systematic, and frequent collections in all parts of the protected territory indicate the lack of local efficiency in time to prevent the mosquito fauna from reaching the danger point. It is the writer's belief that frequent, systematic, and regular night collections of mosquitoes on the wing should be made throughout the heavy breeding season, and that every mosquito fighting organization should make arrangements to have the specimens, which are collected, worked up and the results interpreted within 24 hours of the time the specimens have been taken.

Cost of Mosquito Control

Table Showing Distribution of Expenditures

	County A		County B			County C		
Year	1913	1914	1912 (5–6 mos.)	1913	1914	1912 (5–6 mos.)	1913	1914
Cost of Mos. Control								
Administration	13%	14%	12%	12%	14%	9%	13%	17%
Inspection	18%	20%	45%	31%	24%	24%	28%	33%
Elimination	31%	32%	19%	21%	23%	32%	31%	21%
Equipment	5%	4%	9%	5%	7%	6%	6%	6%
Education, Rept. & Miscellaneous	1%	1%	1%	1%	1%	2%	7%	4%
Salt Marsh	32%	29%	14%	30%	31%	27%	15%	19%
Per capita	5.07¢	5.42¢	6.37¢	11.9¢	11.37¢	10.57¢	28.22¢	15.89¢
Per sq. mile of habitable area	$461	$512	$349	$375	$357	$117	$272	$195

In reckoning the total cost of mosquito control, the lump sum expended should not be considered because the most tangible and immediate benefit derived does not admit of similar aggregation. Stating the matter in another way, it should be said that inasmuch as the most tangible and immediate benefit is personal, the cost should be reckoned on a per capita basis. From this standpoint mosquito control in County A cost 5.07 cents and 5.42 cents in 1913 and 1914; in County B, 6.37 cents, 11.9 cents and 11.37 cents in 1912, 1913 and 1914; while in County C it cost 10.57 cents, 28.22 cents, and 15.89 cents in 1912, 1913 and 1914.

For an explanation of these differences in per capita cost of the work, the conditions under which it was done must be examined. The work of 1912 began late and represents only 5–6 months. During the only years (1913 and 1914) when the three counties (A, B and C) were at work coincidently the percentage of the total expenditure, in Counties A and B, devoted to the salt marsh, was the same while County C spent about one-half as much as each of the others. The upland area of County A is only one-third that of County B and less than one-half that of County C. County A has a population of 13,275 to the square mile, County B, 4,515 and County C, 1,526.

On the basis of unit area (say per square mile) County A expended $461 in 1913 and $512 in 1914 as compared with $375 and $357 in County B, and $272 and $195 in County C. This higher unit-area cost is not due to poorer drainage conditions, for the upland in County A is better drained than that of either County B or County C. It seems rather to be chargeable to the larger number of breeding places which is incident to a denser population.

On the basis of per capita cost per unit of upland area the results are quite different. The per capita cost per square mile was 3.4 cents in 1913 and 3.8 cents in 1914 in County A, 8.3 cents and 7.8 cents in County B and 17.8 cents and 12.8 cents in County C.

It is distinctly indicated by these facts that other things being approximately equal, the cost of controlling mosquito breeding on the upland increases per unit of area as the population grows denser, but that the per capita cost decreases as the density of population increases.

Results of Mosquito Control

The results of mosquito control appear in increased comfort and health, and in increases in property values. No investigation of effect on property values has been made and there exist no reliable malarial records on which to base conclusions.

Evidences of results must therefore appear in what the people who are protected say and do about it. The first evidence is the attitude

of the newspapers which has become universally favorable. The second evidence appears in the attitude of the legal representatives of Counties A, B and C, who seem unwilling to tolerate any interference with the law under which the work is done. The third evidence is found in a post card census recently taken by the writer. A mailing list was made up from the telephone directory—so many A's so many B's, so many C's and so on through the alphabet, were taken from the lists of the various cities and towns within the limits of Counties A, B and C. To each member of this mailing list a letter was sent in which the expenditure that had been made during each year of the work in his county was set forth and he was asked to state on a stamped addressed card whether he had received an amount of protection equivalent to his share of the expenditure, and whether he approved the continuance of the work. One hundred and ninety-one cards have been received, 117 of which hold that they have had value received, 52 are doubtful, and 12 are sure they have not. Of the 191 cards received, 178 want the work continued and 13 desire it stopped.

PRESIDENT H. T. FERNALD: The next paper on the program will be presented by R. A. Cooley.

THE SPOTTED FEVER TICK (DERMACENTOR VENUSTUS BANKS) AND ITS CONTROL IN THE BITTER ROOT VALLEY, MONTANA—A REVIEW

By R. A. COOLEY, *Bozeman, Montana*

The purpose of this paper is to present in the briefest form, a summary of our knowledge of the Rocky Mountain spotted fever tick (*Dermacentor venustus* Banks) in Montana and to outline the control work now in progress.

This arachnid is the subject of much interest in the northwest for three reasons: (1) It is the carrier of Rocky Mountain spotted fever, (2) Recently it has been shown to be responsible for a new disease of man and certain domestic animals which has been given the name, "tick paralysis," and, (3) Finally, it is well recognized as a troublesome parasite of man and domestic animals.

ROCKY MOUNTAIN SPOTTED FEVER

By all odds the most important of the three is the relation to spotted fever. This disease has been scatteringly recorded over a wide ter-

ritory in the northwest, its distribution following, in a general way, that of the tick as given below. Spotted fever has not been well known among physicians in the wide range of territory indicated by the scattering cases reported and it is probable that many cases have passed unrecognized. It is best known in Montana and Idaho; and in Montana interest in the disease centers in the Bitter Root valley where most of the cases have occurred.

In Idaho the number of cases reported ranges around 375 to 400 per year with an average mortality of approximately 5 per cent; [1] while in the Bitter Root valley, Montana, the cases have ranged from 28 downward with an average of about 12 during recent years, but with a mortality of around 85 per cent. The fact that spotted fever is so fatal in Montana accounts for this state's being the center of interest in this disease.

Influence on Property Values and Business

There can be no doubt that the presence of spotted fever has influenced property values and the volume of business in the immediate region affected and also that exaggerated reports which have become current in the United States have injured the reputation of the state as a whole. Outside of the Bitter Root valley, and the region close around, spotted fever occurs in Montana, so far as is known, only in a restricted area in Carbon county, just north of Wyoming. In Idaho and Wyoming, and in Carbon county, Montana, spotted fever is not much feared on account of the low mortality and property values are not much affected.

Evidence Against the Tick

From the fact that ticks and tick bites were found on the bodies of fever patients, some residents in the Bitter Root valley had formed the opinion that ticks were the infective agents before scientists announced this fact.

The tick hypothesis first attracted general attention when Doctors Wilson and Chowning published the results of their study made in 1902 and 1903. The work of Doctor H. T. Ricketts, under the auspices of the Montana State Board of Health, established the fact of tick transmission, although somewhat earlier than his work, Doctors McCalla and Brereton in Boise, Idaho, had actually infected a man and a woman with the mild form of spotted fever by allowing a tick to attach to them which had been removed from a fever patient. Doctor Ricketts' work was experimental and methodically carried out. He repeatedly infected guinea pigs and other animals by means of ticks

[1] Maxey, *Medical Sentinel*, Portland, December, 1908.

under laboratory conditions and he collected ticks in nature and demonstrated their infectivity by allowing them to bite guinea pigs in which he had previously learned to diagnose the disease with certainty.

As bearing further evidence, it may be stated that the only precaution which the entomologists have taken in the work in the valley has been against being bitten by ticks and though living in even more apparent danger than the residents themselves, none has been infected.

Geographical Distribution of the Tick

The spotted fever tick occurs in the following states[1]; Washington, Oregon, Idaho, Montana, Wyoming, Nevada, Utah, Colorado, California and New Mexico. It also extends northward into British Columbia.

Only a small proportion of the ticks in the Bitter Root valley are infective and throughout the geographical range of the species, only here and there a locality occurs which contains any infective individuals.

Life-History

An intimate understanding of the life-history of this tick comes only through a knowledge of the host relationships in the various stages, the habits and abundance of the host animals, and the relation of the development of the tick to the succession of seasons.

These subjects will be briefly reviewed.

Host Relationships.—The larvæ and nymphs use very much the same list of mammals as hosts, and availability is apparently a greater factor than choice in determining what species of mammals shall be used. Practically all the species of small mammals occurring in the valley have been found to serve as hosts, but the ground squirrel (*Citellus columbianus*), the pine-squirrel (*Sciurus hudsonicus richardsoni*) and the chipmunk (*Eutamias luteiventris*), because of their numbers and activity, undoubtedly feed the great bulk of all the larvæ and nymphs that secure food. The adults feed only, or with few exceptions, on large animals. Under the conditions that prevail in the Bitter Root valley, as distinguished from the contiguous mountains, practically all of the adults that are fed use domestic animals, horses and cows principally, as hosts. Back into the mountains, ticks become less abundant, disappearing almost entirely when the limit of the range of domestic animals is reached.

Still further back, beyond this limit, in the "goat country," as it is called, or the natural habitat of the Rocky Mountain Goat (*Oream-*

[1] Bishopp. Distribution of the Rocky Mountain spotted fever tick. Circular 136, Bureau of Entomology, 1911.

nus mountanus) a region which is very wild and very inaccessible, this tick is exceedingly abundant. There appears to be an exception to the limitation of ticks to the range of domestic animals, in the mountains near Victor, where, as Doctor L. D. Fricks has pointed out, ticks continue to be abundant beyond these limits. Outside of this exception, the number of adult ticks that engorge on wild animals either in the valley floor, the first reaches in the mountains, or deeper into the mountains below the goat ranges, is so small as to be of no particular significance from a control standpoint. Or, in other words, if those which develop on domestic animals were entirely eliminated, ticks would scarcely ever be seen by those who reside in the valley and infections would cease.

The ticks are more abundant than elsewhere along the border country, between the valley and the mountains. The presence of a known danger there makes this border country less desirable for tillage purposes and it is naturally given over to pasturage, and, as ground squirrels are abundant there, the conditions are made perfect for a continuation of the difficulty.

The host relationships may be summarized then by saying that the mature stages are fed on small mammals only and the adults, practically speaking, are confined to domestic animals, so far as the habitable valley is concerned, with the exception of a certain mountainous district back of Victor.

These facts have an important bearing on eradication. Domestic animals can be controlled. By dipping and by other means they may be kept free of ticks and if the species is prevented from engorging and laying eggs, it must die out, and with the disappearance of the tick, the disease must go.

However, certain facts connected with the seasonal history also have an important bearing on control and these are now discussed.

Seasonal History

Previous workers had believed that the tick completes the life cycle in one year. When in 1911 detailed records were secured this was found to be quite impossible. It was found that the winter is passed both as adults and as nymphs, but that the hibernating individuals of these two stages belong to different generations. On these grounds, therefore, it was necessary to conclude that the life-cycle is at least two years long.

In connection with longevity studies, it has been shown that adults which fail to secure a host during the first season following nymphal feeding, do not die but go down to the ground during July and come up again the next year, in the spring, and continue to wait for a

host. Thus, it is apparent that a part of each brood may prolong life in this manner, thus making the cycle three years instead of two.

Studies now under way indicate the possibility of a still further lengthening of the life-cycle.

With these facts in view it is apparent that with very thorough work done in a given district, resulting in preventing any females from engorging and laying eggs for two consecutive years, there still may be adults present in the third season, or if only incomplete work has been done for three or four years even, there still will be adults present in later years.

Control

The foregoing facts regarding the host relationships have indicated a practical plan of controlling the tick in the valley. It is evident since engorgement is necessary before egg-laying, that if no adults are allowed to engorge the species cannot continue. This point is believed to be of much importance and has led to the adoption of dipping of domestic animals as a main dependence in the program. There are two limitations to this method which we recognize, but these we think are not serious. One is the fact that some adults may engorge on wild animals, such as the coyote, bear and deer. These animals are not abundant in the valley and we believe that the small number of engorged adults which they drop may be neglected. The practicability of getting all owners of stock to dip under the conditions found in the valley is more serious. If spotted fever affected the animals instead of man, it would apparently be less difficult to secure the owners' coöperation. A slight danger of injury to the animals is greatly magnified and the residents wish to see some other method of tick destruction developed. The arsenical dip in use has been found to be effective and we believe that as the farmers gain confidence dipping will be more generally adopted. However, notwithstanding this limitation many animals are already being dipped and thereby freed of ticks.

Rodent destruction naturally suggests itself as a method of control. Ground squirrels are very abundant and the property owners are quite willing that they should be killed off. Some work in this direction has been done and there can be no doubt that it is of value in the destruction of ticks as we have found that this rodent, far more than any other, is responsible for the feeding of larvæ and nymph ticks. The cost of this work under the conditions that prevail in the region affected is such as to raise a serious obstacle. This might, however, be overcome if the killing of this squirrel alone would be a sufficient means of getting rid of the tick. It is apparent that since the early stages of the tick feed also on other rodents, other means of tick killing will eventually be needed. It is not yet clear that with ground squirrels eliminated there

may not yet be enough young fed on other rodents to keep up a serious infestation if domestic animals are allowed in the same territory and left undipped.

It seems probable that squirrel destruction is desirable only in combination with dipping and that in this combination it will be useful and lead to an earlier solution of the difficulty.

Recently Doctor L. D. Fricks of the United States Public Health Service has advanced the idea that the grazing of sheep over tick country may be useful as a supplementary method in the destruction of ticks. He has found that many adults are killed in the wool of the sheep. Experimental work and practical tests are being conducted. The Bureau of Entomology has also made some studies on sheep as automatic destroyers and has found that some females engorge on the sheep and produce eggs which hatch.

The work on sheep as tick destroyers is in an experimental stage. It is not yet clear whether the number that will succeed in feeding to maturity on sheep will be a serious drawback to this method.

Organization

The work on tick control in Montana is being conducted under a plan of coöperation embracing the Montana State Board of Entomology, the United States Bureau of Entomology and the United States Public Health Service. The State Board of Entomology was created by the Montana Legislature in February 1913. The membership of this Board is *ex officio* and made up of the secretary of the State Board of Health, the State Veterinary Surgeon and the State Entomologist. The secretary of the Board of Health is chairman and the Entomologist, secretary. This Board is given authority among other things, to prescribe and enforce rules and regulations for the eradication of the spotted fever tick. The two federal services named are engaged in the work in different portions of the Bitter Root valley, under such legal machinery from the State Board of Entomology as has been found necessary from time to time.

The technical information concerning the tick on which the control work is mainly based, has been secured through the joint efforts of the Montana Experiment Station and the Bureau of Entomology. The work has been planned and directed by Mr. W. D. Hunter and the writer, while various men in the Bureau have contributed valuable assistance. The field work in the Bitter Root valley was done mainly by Mr. W. V. King, and the breeding and other laboratory work was done in the Bureau's laboratory in Dallas by Messrs. C. F. Bishopp and H. P. Wood.

The Bureau of Biological Survey, through Dr. A. K. Fisher, gave

us invaluable assistance by securing needed information concerning the mammalian fauna of the valley and nearby mountains and especially by certain experimental work on the destruction of squirrels. The field work for this Bureau was done by Mr. A. H. Howell and Mr. C. Birdseye.

An unusual character of personal service has been willingly given by those who have been engaged on this problem in the field work. This applies alike to the pathologists, the entomologists and mammalogists who have not hesitated to go into the presence of known danger. Especial mention should be made of Messrs. King, Fricks, Birdseye and Wood who have made prolonged stays in the field and finally of Dr. H. T. Ricketts who through several years was almost constantly exposed to dangers known and unknown and finally lost his life by typhus fever while engaged in what was really a part of the spotted fever investigation and of Dr. T. B. McClintock who contracted spotted fever and gave his life, while engaged in the field, a sacrifice to his devotion to this cause.

This devotion has not been in vain. There can be no doubt that a considerable number of lives have already been saved. In spite of the fact that the population of the Bitter Root valley is increasing and of the further fact that the disease is slowly spreading, fewer cases have occurred in recent years since the work was begun than before. During the season just closed only one case occurred in the heart of the district where in former years a high proportion of all the cases have been contracted. The cases recorded this year were with the exception of this one, from territory where the work was not begun. This is due not to any material reduction of ticks as yet, but to the adoption by many of the residents of the valley of the means of self defense employed by the scientists who are in the work.

Bringing the spotted fever tick under complete control will require some years. The territory involved is extensive and the methods which will be effective in one district will not be as effective in another. Educational work among the people must be pushed in advance of actual control and the life history of the tick is such that thoroughly effective measures must be pursued through a term of years in order to secure the desired end.

PRESIDENT H. T. FERNALD: Is there any discussion on this paper?

VICE-PRESIDENT HERRICK: I would like to ask Professor Cooley if the tick was responsible for the paralysis in those sheep shown on the screen?

MR. R. A. COOLEY: Yes. I would call attention to a recent work

by Doctor Seymour Hadwin, published in the *Journal of Parasitology*, and also to the expression of a definite opinion by Doctor George H. F. Nuttall of England to the effect that we should no longer hesitate to say that this is a definite disease. The ticks attached and induced the paralysis. They often attach on the base of the skull or along the spine. The paralysis progresses from the lower part upward and the removal of the tick results in a sudden recovery of the child.

PRESIDENT H. T. FERNALD: Mr. F. C. Bishopp has submitted a title and asked for fifteen minutes. He desires to present two short papers in this time. If there is no objection, both will be presented within the fifteen minute time limit.

[The speaker summarized two papers. One is given below. The other will appear with papers read by title. ED.]

NOTES ON CERTAIN POINTS OF ECONOMIC IMPORTANCE IN THE BIOLOGY OF THE HOUSE FLY[1]

By F. C. BISHOPP, W. E. DOVE, and D. C. PARMAN, *Bureau of Entomology*

The first impression one gains by running over the voluminous literature relating to the house fly or typhoid fly (*Musca domestica* Linn.) is that our knowledge of that insect and its control leaves little to be desired. To be sure, the admirable investigations of Doctor Howard, Doctor Hewitt, and many other entomologists here and abroad have given us complete and reliable information on the vast majority of points in the life history and habits of this pest and have pointed out means of their practical application. However some points have not been determined while others which have been investigated should receive further attention. The importance of accumulating information regarding the biologies and habits of insects of wide distribution in a number of regions representing different climatological or economic conditions, is coming more to be recognized.

At the suggestion of Dr. L. O. Howard and Mr. W. D. Hunter experiments were undertaken to determine, under Texas conditions, two of the more important biological questions requiring further study. These were the duration of the period from emergence of the adult fly to the deposition of the first eggs (spoken of herein as the preoviposition period) and how the insect passes the winter. It was thought best in carrying out these experiments to broaden the inquiry so as to obtain accurate information on other important points. These included: The determination of the duration of the different developmental stages of the insect, the longevity of adults, the number of

[1] Published by permission of the Chief of the Bureau of Entomology.

depositions and interval between each, and notes on the effect of temperature and humidity on the several stages. Some part of these are discussed herein. The character of most of the biological points to be determined necessitated the use of cages. It is well known that conditions in cages are always more or less abnormal. This is true in the tests herein reported, but we feel that by the methods employed natural conditions were closely simulated in most cases, thus reducing this source of error to a minimum. The tables given herein include representatives chosen from numerous experiments carried out.

The experimental work was carried out at Dallas and Uvalde, Texas, with supplementary field observations at Victoria, Texas, by Mr. J. D. Mitchell. The detailed work at Dallas was carried out by W. E. Dove, assisted by F. C. Bishopp, who planned and supervised all of the work, and the experiments at Uvalde were carried out by D. C. Parman.

Further experiments bearing on hibernation and certain other points are now under way at Dallas and Uvalde.

Copulation

In a number of our preoviposition tests frequent observations were made for copulation. Although continuous watch was not kept on the flies it is thought that in some cases at least the first copulation which took place was observed. The date when copulation was observed in a number of experiments is given under "Remarks" in Table No. 1. The shortest period from emergence to copulation observed was one day. In a number of instances two full days elapsed, and in other cases copulation was first observed as late as the sixteenth day after emergence. Of course mating may have taken place unobserved before this. The time from the first observance of copulation to the first deposition varies greatly. Frequently there appears to be no direct relationship between the date of copulation and beginning of deposition. We have observed a range of two to thirteen days between the first copulation observed and deposition.

It appears from our experiments that the time of development or manifestation of the desire to mate is influenced to some extent at least by the food of the adults. Thus in a test with two lots of flies, one supplied with milk and horse manure and the other with partially ripened peaches and horse manure, the former were first observed to copulate four days after emergence and the latter sixteen days. In no case was copulation observed among unfed adults.

The process of copulation is always of considerable duration—lasting from two or three to as long as fifteen minutes. During the act the flies usually remain quiet, but if disturbed may fly about considerably without becoming separated. Often prior to copulation and

TABLE 1. PREOVIPOSITION PERIOD OF THE HOUSE FLY AT DALLAS, TEXAS

Adults Emerged	Number Adults ♂	Number Adults ♀	Number Adults Total	Food Supplied	Breeding Media Supplied	First Eggs Deposited	(Preoviposition Period (shortest)	Temp. During Preoviposition Period Highest	Temp. During Preoviposition Period Lowest	Temp. During Preoviposition Period Average Daily Mean	Remarks
1913 July 28, 5 p.m.–July 29, 12 m.	11	7	18	Peaches and horse manure	Horse manure (not fresh)	Aug. 6*	Days 8 (about)	°F. 104.0	°F. 69.9	86.0	*One day old larvæ found Aug. 7, p.m.
Aug. 6, 3.30 p.m.–Aug. 7, 10 a.m.	....	....	225	Peaches and horse manure	Horse manure	Aug. 14*	8 (about)	105.0	71.5	88.3	*One day old larvæ found Aug. 15.
Aug. 14, 6 p.m.–Aug. 15, 10 a.m.	....	....	9	Peaches, water, horse manure	Horse manure (fresh)	Aug. 18, 4 p.m.	4	102.4	72.5	87.5	Copulation Aug. 16, 3 p.m.
Aug. 19, 5.30 p.m.–Aug. 20, 9.30 a.m.	4	8	12	Peaches	Peaches	Sept. 5, 9 a.m	16	104.4	65.5	85.2	Copulation Aug. 22, a.m.
Aug. 20, 5.30 p.m.–Aug. 21, 10.30 a.m.	11	11	22	Milk, peaches, horse manure	Horse manure	Aug. 26, 9 a.m.	5	101.8	65.5	83.9	
Aug. 24, 5.30 p.m.–Aug. 25, 10 a.m.	1	1	2	Milk, peaches, horse manure	Horse manure	Sept. 6, a.m.	12	106.0	69.0	85.9	Copulation Aug. 27, a.m.
Aug. 27, 5.30 p.m.–Aug. 28, 9 a.m.	1	1	2	Milk, peaches, horse manure	Horse manure	Sept. 5, 4 to 5 p.m.	9	106.0	69.5	86.0	Copulation Aug. 29, a.m.
Sept. 8, a.m.	7	2	9	Milk, peaches, horse manure	Horse manure	Sept. 15, p.m.	8	92.0	56.6	72.0	

Sept. 11, a.m.	....	....	A No.	Milk, horse manure	Horse manure	Sept. 16, p.m.	6	83.0	56.6	67.6	Copulation Sept. 15, a.m.
Sept. 11, a.m.	....	....	7	Peaches, horse manure	Horse manure	Oct. 1, a.m.	20	92.7	47.1	68.1	Copulation Sept. 27, a.m.
Nov. 7, 10.30 a.m.–2.30 p.m.	5	5	10	Horse manure, milk and bananas	Horse manure	Nov. 20, a.m.	13	80.0	33.7	64.0	Copulation Nov. 15, p.m.
1914 May 16, 10.30 a.m.–2.30 p.m.	....	....	Many	Bananas, horse manure	Horse manure	May 20, 4 p.m.	4½	81.3	51.9	68.8	Copulation May 18, p.m. medium cage.
June 23, 3 p.m.–June 24, 3 p.m.	....	....	100	Milk, plums, horse manure	Horse manure	June 29, p.m.	6	101.5	73.1	86.9	
July 3, 9.30 a.m.–2.30 p.m.	....	....	18	Milk, plums, horse manure	Horse manure	July 9, p.m.	7	94.1	70.7	87.8	
July 8, 5 p.m.–July 9, 5 p.m.	....	....	350	Milk, peaches, *cow manure, horse manure	Cow and horse manure	July 14, m.	5½	104.0	73.9	87.7	*Cow manure supplied till July 16. Many females deposited.
July 9, 9 a.m.–July 10, 9 a.m.	....	1	1	Milk, bananas, peaches, *horse manure	Horse manure	July 17, by 10 a.m.	7	104.0	73.9	88.1	*Horse manure supplied July 16, 4.30 p.m.
July 27, 10 a.m.–July 28, 10 a.m.	....	....	200	Cantaloupe, horse manure	Horse manure	Aug. 2, p.m.	7	104.3	70.0	87.3	Copulation Aug. 1, p.m. Large cage.
Oct. 22, 10 a.m.–5 p.m.	....	....	700	Milk, bananas, cow manure, horse manure	Cow manure, horse manure	Nov. 1, between 9 a. m. and 4 p. m.	10	84.9	32.1	61.9	Oct. 27, a.m. 1st copulation observed. Large cage.

after copulation has taken place the sexes fly together or the males temporarily alight on the females. This appears to be in the nature of courting. When not ready to accept the attentions of the male the female protects herself largely with her posterior legs which are kept near the tip of her abdomen.

The Preoviposition Period

In 1907, Dr. C. Gordon Hewitt, working in England, found that a period of fourteen days elapsed between the emergence of adults from puparia and the first egg deposition by them.[1] In experiments at Hove, England, Dr. A. Griffith determined the preoviposition period to be ten days.[2] Professor A. Berlese has also published results of observations made by him on the reduction of numbers of the house fly in S. Vincenzo, Italy, due to the poisoning of adult flies incidental to the spraying of olive trees for the control of the olive fly.[3] Professor Berlese also secured satisfactory results in controlling the insect by spraying vegetation, manure and garbage with poisoned sweets.

In order to determine the preoviposition period a series of experiments were conducted at Dallas and Uvalde. In these tests cages of various sizes from one foot cubes to cages ten feet square by six feet high, were utilized; the latter appeared to furnish almost ideal conditions. These were placed in partial or complete shade or in open sunshine. Freshly emerged flies were used in numbers varying from a pair to several hundred. Different kinds of food were supplied and the breeding media were also varied. A few of the experiments are summarized in table 1.

It will be seen in Table No. 1 that the shortest preoviposition period observed at Dallas was four days and the longest twenty days. The mean temperatures during these periods were 87.5° F. and 68.1° F., respectively. The usual preoviposition period during the summer at Dallas appears to range from four to about nine days. While in autumn it is probably never shorter than ten days. Although it is certain that temperature has much to do with the development of the ova in flies, it is also evident that the food supply, both abundance and quality, is an important factor. This is well illustrated in the lot of flies which emerge between August 19, 5.30 p. m. and August 20, 9.30 a. m. and were given nothing but cut peaches for food and breeding medium as compared with flies which emerged between August 20,

[1] 1910. Hewitt, C. Gordon. The house fly; a study of its structure, development, bionomics, and economy, p. 64.

[2] 1908. Griffith, A. The life history of house flies. *Public Health*, Vol. XXI, pp. 122–127.

[3] 1913. Berlese, A. La distruzione della Mosca domestica. *Redia*, Vol. VIII, Pt. 2, pp. 462–472, 4 figs.

5.30 p. m. and August 21, 10.30 a. m. and were supplied with milk, peaches, and horse manure. The temperature and humidity in these two cases were practically identical, yet the flies on peaches required sixteen days for egg production while those given the variety of foods deposited in five days.

The humidity also appears to have a bearing on the duration of this period. In general when the temperatures are high or moderately high, increased humidity seems to hasten egg laying. This is probably partially due to the effect of humidity on the food and breeding substances—keeping them moist and thus attractive. Our observations lead us to think that sunshine, aside from higher temperature, has a stimulating effect on reproduction and other activities in flies.

The preoviposition periods recorded in the table are the shortest observed in each lot of flies; in many cases only a few masses of eggs were deposited in a test. In several tests, with large numbers of flies under favorable conditions, a number of females began depositing about the same time, or not more than twenty-four hours later than the first.

In most of our tests with single pairs the preoviposition periods were longer than when a number of flies were kept together.

At Uvalde several preoviposition experiments were conducted but in nearly all the flies failed to deposit. In one test made in June the period was about six days.

Milk appears to be a good food for ova development. This substance with manure was found to be adequate for producing oviposition. Over-ripe fruit with manure was also found to be satisfactory. The effect of the condition of food on egg production may be illustrated by referring to Table No. 1. In one instance where milk and horse manure were supplied deposition took place in six days. In a parallel test where partially ripened peaches were substituted for the milk, the first deposition occurred on the twentieth day after emergence. Manure either of horses or cattle, appears to be inadequate as a food for egg production in the house fly.

Based upon our experiments it appears that, in Texas, it is necessary to capture or destroy the female flies within four days after emergence in summer and within ten days in fall and early spring in order to prevent reproduction. The shortness of the preoviposition period as determined by us emphasizes the importance of laying special stress on the prevention of breeding by caring for breeding media, as urged by Doctor Howard, rather than the destruction of adults, as the more important control measure. This seems especially true in the tropics and subtropics where the preoviposition period is short, successive depositions frequent and longevity of the adult reduced.

Deposition

The determination of the egg-laying period of a fly or group of flies is important in that it shows the value of destroying the adult at different times in its career as relates to reproduction. In most of our tests the total time from the beginning of laying to the deposition of the last eggs was comparatively short, the adults often living several days after the last eggs were deposited.

Dr. A. Griffith, reporting on experiments conducted by him in England, says: "After ten days the mother-fly can lay a new batch of eggs, which process it repeats at intervals of ten to fourteen days, till four batches have been layed, when it dies."[1] Our observations indicate that in Texas fewer batches of eggs, the usual number being two, are deposited and that depositions take place at shorter intervals—about eight days.

Oviposition was observed to occur on warm days in mid-winter at Dallas (January 14) and Uvalde (February 5). Depositions may be expected at these latitudes on mild bright days in winter, especially if these are preceded by a few days of mild weather.

During cool weather adults seem to choose places for deposition where the sun is bright and the wind is cut off. They also prefer portions of the pile where heat is emanating from beneath, provided the media is suitable. In summer this is less noticeable though in mornings and evenings sunny places seem preferred.

We have observed a marked tendency to clustering of eggs in one place on manure piles. In many instances from three to over a dozen flies have been observed depositing in one spot in a manure pile and scarcely a depositing fly or an egg could be found elsewhere, although equally favorable places seemed to exist. This habit of association of individuals seems to continue to some extent in the larval stage, although this is probably more dependent on suitable feeding places, and the fact that the larvæ hatch largely in one mass. Great masses of larvæ have also been observed to pupate in one place. This is probably due, in part at least, to many of the larvæ following the line of least resistance in migrating and the finding of a place which furnishes proper protection and moisture and is not too compact.

Developmental Periods

Incidental to other observations the developmental periods were determined in a large series of tests at different times of year. The total period from the deposition of the eggs to the emergence of adults

[1] 1908. Griffith, A. The life history of house flies. *Public Health*, Vol. XXI, p. 123.

in our breeding experiments ranged from eight days to fifty-one days. A much longer period was observed in hibernation experiments at Dallas and Uvalde, Texas. In one of these tests at Dallas a combined larval and pupal period of six months was observed and in the instance at Uvalde larvæ and pupæ put in a box with the manure in which they were breeding on December 13, 1913, produced some adult flies as late as April 4, 1914, a period of one hundred and twelve days. The amount of manure was not sufficiently large to generate heat, but protected the stages from extreme cold. No doubt during the coldest weather development was completely arrested.

The data appertaining to a number of the tests to determine the developmental periods are given in Table No. 2. In most of these tests a comparatively small amount of breeding material was used in order to observe the stages more closely. Hence these periods, especially the larval, are in general rather longer than would occur under favorable natural conditions.

Egg Stage.—The exact incubation period was determined in only a few instances. In practically all cases it was found to be less than twenty-four hours even in winter. When eggs are deposited on manure piles of considerable size the temperature experienced by them is much above the air temperature during cool weather, and this accounts for the short periods observed in winter. When eggs are separated from the mass of manure the period is greatly lengthened during cool weather. This is well illustrated in two of the lots upon which data are given in Table No. 2. In one case, eggs deposited on January 14, 1914, hatching of those left on a manure heap took place in less than seventeen hours, while part of the same lot kept in the laboratory on a small lot of manure did not begin hatching until forty-one hours after deposition, and was not complete till eight hours later.

Larval Stage.—The larval stage was found to vary in length from three and one-half days to about three weeks. In a hibernation test where the manure was not in a fermenting condition the larval stage was observed to persist for nearly four months. In one case a period of a little less than three days was observed. The usual time required from hatching to the formation of the first pupæ during warm weather was from four to seven days. The temperature materially affects the larval period but the character and particularly the amount of the breeding medium was found to be of still greater importance as factors, under natural conditions. By character we refer to the kind of material, the amount of moisture it contains, and the degree of fermentation. In large piles of manure it was observed that to a marked extent the larvæ govern their temperature conditions by penetrating farther into the manure during cold weather and remaining nearer the surface when the weather was warm.

TABLE 2. DEVELOPMENTAL PERIODS OF THE HOUSE FLY AT DALLAS, TEXAS

Date First Eggs Deposited	Date Hatching Began	Incubation Period	Date of Pupation		Length Larval Stage	Date Adults Emerged		Range in Pupal Period	Total Developmental Period		Breeding Media	Remarks
			First	Last		First	Last		Min.	Max.		
1913 July 29, 11.30 a.m. –12.30 p.m.	1913 July 30 before 10 a.m.	Hours 22½–	1913 Aug. 3 before 9 a.m.	1913	Days 4	1913 Aug. 6, 10 a.m.–3.30 p.m.	1913 Aug. 9, a.m.	Days 3 to 6	Days 8	Days 11	Horse manure	Small cage in laboratory.
Aug. 18, 3.45 p.m. or before.	Aug. 19, 2.30 p.m. or before	23+	Aug. 23 before 10.30 a.m.	Aug. 25,	4–	Aug. 27, 10 a.m.–5.30 p.m.	Aug. 30, 11.30 a.m.	4 to 7	9	12	Horse manure	Small cage.
Aug. 26, 9 a.m.	Aug. 27, before 9.30 a.m.	24½+	Aug. 31, 12 m.	Sept. 6, 9 a.m.	4	Sept. 7, 5 p.m.	Sept. 11, a.m.	7+ to 10	13	16	Horse manure	Small cage.
Aug. 28	.....	.....	Sept. 5	.....	7–	Sept 8, a.m.	Sept. 16+	3 to 11	11	19+	Horse manure	Large mass of manure. Adult emergence not observed after Sept. 16.
Sept. 4, 3 p.m.–5 p.m.	Sept. 5 before 9 a.m.	18–	Sept. 10, a.m.	.....	5	Sept. 18, a.m.	Sept. 25, a.m.	8 to 15	14	21	Horse manure	
Sept. 11, p.m. (?)	Sept. 12, a.m.	24–	Sept. 23, a.m.	Sept. 26, a.m.	11 to 14	Sept. 30, a.m.	Oct. 1, a.m.	5 to 8	19	20	Horse manure	Small cage.
Sept. 15, p.m.	Sept. 16, a.m.	24–	Sept. 29, a.m.	.....	13	Oct. 5, a.m.	Oct. 5, a.m.	6	20	.....	Horse manure	Medium cage.

1914 Jan. 14, 4 p.m.	1914 Jan. 15 before 9 a.m.	Hours 17½—	1914 Feb. 5 or before.	.....	Days 21—	1914 Feb. 8 or before	.....	.....	Days 25	.....	Horse and cow manure and straw	In large manure pile, Feb. 5 many larvæ present also.
Jan. 14, 4 p.m.	Jan. 16, 9 a.m.	41	Feb. 3 or before	.....	23 or less	Mar. 6, a.m.	.....	26 or more	51	.....	Horse manure	Small cage in laboratory.
Apr. 1, 2 p.m.	Apr 2, 10 a.m. Apr. 3, 9 a.m.	24 to 48	Apr. 11 (?)	.....	8+	Apr. 16, a.m.	Apr. 19, a.m.	3? to 8?	15	18	Cow manure	Small cage in manure pile.
May 20, 4 p.m.	May 21 before 10 a.m.	18—	May 24, p.m.	.....	3½	May 29, a.m.	June 1	5 to 8	9	12	Horse manure	Small cage.
May 27	May 28	24+	June 14	.....	17	June 20	.....	6	24	.....	Bananas	Small cage.
July 9 before 5 p.m.	July 10 before 9 a.m.	.....	July 18, probably before	.....	8	July 20	July 23	.....	11	14	Horse manure	Small cage.
July 14, 10 a.m.–12 m.	July 15 before 9 a.m.	23—	July 19, 9 a.m.	After July 23	4 to 8+	July 24, 10 a.m.	July 26	5	10	12	Cow manure	A few larvæ not pupated July 23.
Aug. 4 after 3 p.m.	Aug. 5, 9 a.m. or before	18—	Aug. 11, 8 p.m.	Aug. 20	6	Aug. 14, p.m.	Aug. 17, a.m.	3 to 6	10	13	Dead flies	Last pupæ died.
Aug. 5, 9.30 a.m.–5.30 p.m.	Aug. 6 before 9 a.m.	23½+	Aug. 8, p.m.	After Aug. 17	3—	Aug. 13, a.m.	Aug. 19	5	8	14	Horse manure	
Oct. 3, 1.30-2.30. p.m.	Oct. 4, 1.30 p.m.	23 to 24	Before Oct. 18	Nov. 4	14 —to 31	Oct. 19	Nov. 7	14+ to 20	16	35	Cow manure	Small cage in laboratory.

PUPAL STAGE.—The pupal stage was found to range from three to at least twenty-six days in our experiments to determine this point with exactness. The temperature is an important governing factor. It is probable that its influence on the length of the pupal period is even more marked than on the length of the larval stage as the pupæ are usually more removed from the heat of the manure and they have no way of accommodating themselves to changes in temperature, as do the larvæ. In one of our hibernation experiments at Uvalde, Texas, in 1914, it appeared that a good many individuals remained in the pupal stage from January 27 to April 4, or over two months.

BREEDING MATERIAL

As has been observed by many entomologists, horse manure is a very favorable breeding medium for the house fly. In Texas we have found them to breed freely in the manure of the chicken, hog, goat, and to a large extent in pure cow manure, provided other more attractive media are not present. The latter substance is not as attractive as some other materials. Decaying vegetable matter and kitchen refuse also form important sources for fly breeding; this is especially true around cities where rather large accumulations of each substance are found. At the dumping grounds around Dallas large quantities of decaying potatoes were found which seemed to be ideal for house fly breeding, producing countless numbers of them. Decaying melons and mixtures of kitchen refuse were also found to breed considerable numbers. The paunch contents of animals were found to furnish favorable breeding places for house flies after the bodies of the animals had been consumed by scavengers. In the grain belt of Texas, Oklahoma, and the states to the north, the bases of stacks of oat or wheat straw which had become well rotted were found in some instances to breed many house flies. The straw during the first year after thrashing, although in a high state of fermentation, is not favorable for house fly breeding although myriads of stable flies may breed in it. Well-decayed straw stacks or the remains of stacks after being burned should be considered in fighting the house fly in rural communities. Ensilage scattered about silos or in troughs has been found very favorable for house fly breeding, and fermenting cottonseed hulls mixed with bran, etc., in the bottom of feed boxes or troughs have been found to produce flies beyond all expectations.

LONGEVITY

When considering the destruction of house flies in the adult stage the question of their longevity is one of importance. A number of experiments upon this point have been conducted in Europe, but little

is known regarding longevity in the United States, particularly in the Southern States. In England, Doctor Hewitt found it possible to keep house flies alive for seven weeks in the summer time. Doctor Griffith, in his experiments, also in England, had a fly live for sixteen weeks.

We have conducted a large number of experiments in Dallas under varying conditions of climate, food, and cages. Representative experiments are cited in Table No. 3. It will be observed that the longevity is greatly reduced where food is not given; the usual longevity being from two to three days when no food or water was supplied, while with food supplied it ranged from a very few days up to fifty-three days. This maximum record was made during late fall and early winter. Food and breeding material were supplied and eggs were deposited by flies in this test. In a few tests horse manure alone was supplied. This prolonged life slightly but did not seem to form a maintenance ration, and no eggs were deposited by flies under such conditions. During summer the usual longevity of flies, in cages at Dallas, supplied with an abundance of food and breeding material, was from two to four weeks. Cool weather invariably prolongs the life of the adults, correspondingly delaying reproduction, as has been stated.

Hibernation

It has been assumed generally until recently that the house fly passes the winter in the adult stage only. No definite experiments have been reported to substantiate this belief, although a considerable amount of circumstantial evidence has been presented by various authors; such as the observations by Doctor Hewitt, that flies dissected in fall had much fat stored up in their bodies and in spring this fat was not in evidence.[1] The finding of adults in dormant, semi-dormant and active states in various situations in mid-winter, and the greater longevity exhibited by adults emerging late in fall, has also lent weight to this conclusion. It is our opinion that these conditions do not necessarily indicate that this species passes the winter in the adult stage.

Our experiments, as will be shown later, prove that the house fly can pass the winter in the immature stages in the vicinity of Dallas and Uvalde. Moreover, in our tests we failed to get adults to live through the winter. All our observations indicate that flies which are not kept cold enough to become inactive will either deposit, if the temperature is sufficiently high, or die comparatively soon. It is conceivable that some adult flies may happen to find shelter, which

[1] 1910. Hewitt, C. G. The house fly; a study of its structure, development, bionomics and economy, p. 364.

TABLE 3. LONGEVITY OF THE ADULT HOUSE FLY AT DALLAS, TEXAS

Date Adults Emerged	Number Flies			Food Supplied	Date Last Fly Died	Greatest Longevity	Remarks
	♂	♀	Total				
1913 July 29	11	7	18	Peaches, horse manure	Aug. 16 (♂)	Days 18	Last flies drowned, small cage, eggs deposited.
Aug. 7	....	....	225	Peaches, horse manure	Aug. 20	13	Small cage, eggs deposited
Aug. 15	....	....	9	Peaches, water, horse manure	Aug. 31	16	Small cage, eggs deposited.
Aug. 16	7	7	14	Peaches, water, horse manure	Aug. 30	14	Small cage, no eggs deposited.
Aug. 21	10	10	20	Horse manure	Aug. 25	4	Small cage, no eggs deposited.
Aug. 21	9	11	20	Milk, horse manure	Sept. 10	20	Small cage, eggs deposited.
Aug. 25	1	1	2	Peaches, milk, horse manure	Sept. 23	29	Small cage, eggs deposited.
Aug. 28	1	1	2	Peaches, milk, horse manure	Sept. 17 (♀)	20	Small cage, eggs deposited.
Aug. 28	....	....	16	Water	Aug. 31 (♀)	3	Small cage, no eggs deposited.
Aug. 30	....	....	Many	Horse manure	Sept. 4	5	Small cage, no eggs deposited.
Sept. 11	....	....	25	No food	Sept. 17	6	Small cage, no eggs deposited.
Sept. 11	....	....	48	Water, horse manure	Sept. 18	7	Small cage, no eggs deposited.
Nov. 7	1	1	2	Bananas, milk, horse manure	Dec. 21	44	Small cage, eggs deposited.
Nov. 7	1	1	2	Bananas, milk, horse manure	Dec. 9	32	Small cage, eggs deposited.

1914 Before Apr. 17	1	1	2	Bananas, horse manure	May 14 (♀)	47+	Small cage, ♂ escaped, no eggs deposited.
May 16	....	....	250	Bananas, horse manure	June 8	23	Medium cage, eggs deposited.
June 22	....	....	100	Plums, milk, horse manure	July 18	25	Medium cage, eggs deposited.
July 3	....	....	60	No food or water	July 5, p.m.	3	Medium cage.
July 3	....	....	18	Plums, milk, horse manure	July 30	27	Small cage, eggs deposited.
July 9	....	....	350	Banana, milk, horse manure	July 28	19	Large cage, eggs deposited.
July 21	....	....	200	No food or water	July 23, p.m.	3	Medium cage.
July 23	....	....	75	Peaches, cow manure	Aug. 12	20	Medium cage, eggs deposited.
July 27	....	....	200	Cantaloupe, horse manure	Aug. 16	20	Large cage, eggs deposited.
Aug. 10, p.m.	....	....	150	No food or water	Aug. 12, 11 p.m.	2½	Small cage.
Oct. 22	....	....	700	Milk, banana, manure	Dec. 14	53	Large cage, eggs deposited.

will prevent destruction by cold, and yet with temperatures low enough to prevent activity, and in this way pass the winter. We are inclined to the opinion that the chances of such conditions being found are small and that, although some adults may in this way hibernate, the species is dependent largely on those individuals which pass the winter in the immature stages, or those which continue to breed during the winter. Under Texas conditions we are convinced that this opinion is correct.

To determine the ability of the adults to pass the winter at Dallas, Texas, a cage of screen about ten feet square by six feet high was fitted up with stacks of boards, burlap, paper, etc., for hibernating quarters. Over six hundred adults, about sixty per cent of which were males, were introduced into the cage between November 9 and November 19, 1913. These were mainly newly-emerged adults bred from manure. Food, consisting of bananas, milk, and water, was supplied. Unfortunately the fungus, *Empusæ muscæ*, was unusually abundant during this autumn and the flies in this cage died in great numbers. Probably the majority of them died of this disease. No flies were seen in the cage after November 28, although frequent observations were made during the winter, and in spring a thorough search failed to reveal any living flies in the shelter provided.

At Uvalde, Texas, a similar experiment was conducted, four hundred adult flies being introduced into a large screened cage between December 18, 1913, and January 3, 1914. The flies were supplied with plenty of protection and food. They were observed to seek protection in the rubbish to some extent when the weather became cool. On warm days they resumed activity, feeding, and copulating in some cases.

On January 20, sixty-four adults were found benumbed by cold weather outside of the hibernation material. None of these revived. On January 27, a number were seen to be active in the cage during the warm part of the day. The last adults (two) observed in the cage were seen on January 28. No further activity was noted during the winter and early spring, and no living flies were found on final examination of the hibernation material.

To test the possibility of adults hibernating in buildings where artificial heat is supplied, several hundred flies, bred out in a cage in a small room in the laboratory at Dallas (a great number were also free in the room), were supplied with food, and fire maintained when the weather was cold. The adults began emerging December 30, 1913, from manure infested with larvæ put in the cage December 12. Emergence was allowed to continue for some weeks. The temperature fell to 36° F. on one occasion and once got up to 110° F. for a short time, but usually ran between 50° F. and 75° F. On January 21 larvæ were found which had developed from eggs probably deposited about Jan-

uary 16. On February 21, the last fly in the cage died, thus showing that the greatest possible longevity in this test was fifty-three days.

Turning our attention to our observations and experiments with the wintering of the fly in the immature stages, we find two instances in which we succeeded in carrying the species through in the larval and pupal stages. In one of these tests conducted at Dallas, a large screen cage situated in the country one-half mile from breeding places of the house fly was used. On November 26, 1913, about three barrels of mixed horse manure, cow manure, and straw infested with considerable numbers of larvæ of all sizes and puparia were put into the cage. Some adults began emerging in the cage soon after the manure was introduced. High water covered the manure pile in the cage early in December, but emergence continued after the water subsided until the end of December. No adults were seen to emerge after December 27 until April 16, 1914, when four or five specimens came out, although larvæ were found in the manure in considerable numbers up to March 21. During the latter part of April and early May the manure was again submerged on account of heavy rains, and during this period observations were not made. It seems certain that some larvæ were killed by these inundations. However, on May 26, six vigorous adults were found in the cage. Observations on emergence were not made for some time after this.

We thus have shown that the house fly lived in the larval and pupal stages from November 26, 1913, to May 26, 1914, a period of six months.

It is probable that having this cage placed in partial shade and the inundations to which it was subject retarded the development of the stages, thus accounting for the appearance of adults such a long time after warm weather began. Attention is invited also to the fact that larvæ remained alive, apparently developing slowly during warm periods, from November 26, 1913, until March 21, 1914, the last time the manure was examined. This period covers all of the cold weather usually experienced at Dallas. Had the larvæ, observed on March 21, pupated immediately thereafter and the pupæ produced adults in the usual time, the resulting adults would have found prevailing temperatures sufficiently high to begin reproduction. Hence, we may say that this demonstrates that the larvæ of the house fly may successfully pass the winter at this latitude. If the manure pile had been larger, so as to generate heat, probably the larvæ would have pupated earlier and part of the late winter would thus have been passed in the pupal stage.

At Dallas, the following monthly mean temperatures were experienced during the winter and spring of 1913–14: November, 62.9° F.;

December, 45.0° F.; January, 52.2° F.; February, 43.0° F.; March, 54.5° F.; April, 62.9° F.; May, 71.0° F. The lowest temperatures during the winter were as follows: November, 36° F.; December, 23° F.; January, 25° F.; February, 10° F.; March, 26° F.

A similar experiment was conducted at Uvalde, but with a smaller amount of manure. The manure, consisting of horse dung mixed with straw and infested with larvæ and pupæ, was put in the cage on several different dates, as follows: December 6, December 8, December 9, and December 13, 1913. A total of about two-thirds of a barrel of manure was used. Examinations of the breeding medium made January 14, 1914, and on two subsequent dates, failed to reveal the presence of any larvæ; thus indicating that all had pupated. It is possible, of course, that some larvæ may have been overlooked. Adults continued to emerge throughout the winter except during cold periods. The longest period without emergence was between February 8 and February 16. During this period the daily mean temperature ranged from 39° F. to 61° F. After March 1, from one to nine flies emerged daily up to March 18, when for six days no adults appeared. This, with the exception of March 18 (when the daily mean was 64.5° F.), was a cool period, the daily mean ranging from 42° F. to 59° F. On April 1, 2 and 4, respectively, a single adult emerged and no others appeared after the last mentioned date. During the winter of 1913–14 at Uvalde the monthly mean temperatures were as follows: November, 66.4° F.; December, 54.4° F.; January, 55° F.; February, 54.7° F.; March, 60.1° F. The lowest temperatures during these months were: November, 41° F.; December, 27° F.; January, 23° F.; February, 22° F.; March, 27° F.[1]

Supplementary tests with immature stages were made at Dallas by placing a large number of larvæ and pupæ in boxes of manure under screened cages out of doors. Two thousand larvæ of all sizes, and over one thousand pupæ were used in these experiments. They were picked out of manure, counted and put into small boxes of manure on December 26 and December 30, 1913. Most of the pupæ in these tests produced adults during January and February. On February 28, the last time the manure was disturbed, some larvæ had pupated, but a greater number of larvæ was present. No adults emerged in this cage, and when the final examination was made, on June 6, 1914, no larvæ or puparia were found. Possibly ants destroyed them or the pupæ may have rotted and some of the larvæ may have migrated,

[1] The above temperatures at Uvalde were taken from the Weather Bureau records. Following are the lowest temperatures recorded at the site where experiments were conducted: November, 32° F; December, 27° F;. January, 24° F.; Feburary, 22° F.; March, 28° F.

escaping beneath the cage. The conditions in these tests were not favorable in our opinion for successful wintering, as the amount of manure was small and often it became either too dry or mouldy.

Examinations of chicken manure in poultry houses in mid-winter showed the presence of considerable numbers of house fly larvæ. The conditions in such situations seem especially favorable for the immature stages to pass the winter as the manure generates very little heat, yet being within the chicken house the insects are not subjected to excessive cold. Livery barns furnish somewhat similar conditions, and often great numbers of larvæ are to be found in the cracks of the floors and in corners of stalls. In the South the barns are not heated and the conditions would thus supply uniformly low though moderate temperatures during winter. In the North, where barns are kept heated, there is reason to believe that development and breeding continues during winter in such situations.

Attention has been called in a previous paragraph to the fact that flies emerged during winter at Dallas and Uvalde, and that warm periods occur even in mid-winter which permit of egg deposition by flies in the open.

Our observations on the wintering of the house fly indicate that, in the South at least, winter campaigns against the immature stages are of much importance in control. Destruction of the fly at this time may be easily accomplished by thoroughly cleaning out stables, chicken houses, and animal pens and scattering the manure thinly over fields. Large accumulations of garbage or other breeding media should also receive attention.

PRESIDENT H. T. FERNALD: These papers are now open for discussion.

MR. T. J. HEADLEE: I would like to inquire if a test has been made to determine the rate of propagation of the screw worm fly and experiments conducted for destroying this fly.

MR. F. C. BISHOPP: We are still working on the biological aspects but have done considerable work in destroying carcasses. We have learned that upwards of one million adult screw worm flies can be produced from one. Our main work of destruction is either by burning or burying. Where we hold the fly down to a minimum, we get very few infestations of living animals. It is a matter of keeping the fly reduced to small numbers.

PRESIDENT H. T. FERNALD: We will now listen to a paper by W. E. Britton:

THE ACADEMIC TRAINING OF THE ENTOMOLOGISTS IN COLLEGES AND EXPERIMENT STATIONS OF THE UNITED STATES

By W. E. Britton, *New Haven, Conn.*

In planning this paper, the present writer intended merely to supplement the statistics presented before this association by Dr. L. O. Howard at the Atlanta meeting a year ago and published in the Journal of Economic Entomology, Vol. VII, page 274, June, 1914. It was not intended to discuss the best methods of training, or what should be studied in preparation for entomological work; but simply to ascertain what proportion of these men are college-trained, and what colleges sent them out into the world. At first the scope of the paper included only the entomological workers in the agricultural experiment stations and teachers of entomology in the agricultural colleges. But, there are certain state entomologists, and state horticultural inspectors, as well as teachers in colleges and universities which are not state institutions, all doing creditable work in entomology, and it seemed best to include them.

As the data concerning some of these men were not at hand, a circular letter was sent out October 19, in most cases addressed to the head of the entomological department of each institution, requesting that information be given regarding the academic training of each entomological worker in the department. Of more than sixty such letters sent out, replies were received from about fifty. From *American Men of Science* the writer has been able to obtain data regarding the more prominent entomologists who did not reply, but as a rule could not find there any information about their assistants.

The figures given here are therefore incomplete because the necessary data about a considerable number of men could not be obtained, and these men are therefore not included.

From the start I have avoided names which surely must have been included in Dr. Howard's figures and which would be duplicated if admitted here. Yet I cannot get away wholly from this duplication. It must be remembered that Dr. Riley performed considerable state work before he became Government Entomologist; that his nine Missouri Reports are, and always will be, classics in economic entomology, because his work was so well done and because it was pioneer work; yet Dr. Riley was for so long a time entomologist of the United States Department of Agriculture that we shall always think of him in that connection rather than as state entomologist of Missouri. Likewise Hopkins, Webster, and Quaintance were all engaged in state

work, before joining the Bureau of Entomology, yet they now seem so much a part of the Bureau that we can hardly consider them as belonging elsewhere. None of these men were included in the figures given in this paper. On the other hand such men as John B. Smith, and J. H. Comstock, who were once connected with the Department of Agriculture, and J. M. Aldrich, who has recently joined the Bureau force, have spent so many years of service in the states in comparison with the short period in Government service that they seem to belong to the former instead of the latter and have been so considered.

All present official entomologists and their trained assistants in the various states are also included. Thus such names as those of Dr. Hinds, Dr. Morrill, and Mr. Sanders probably figure in both Dr. Howard's paper and this; and no doubt some have been omitted from both.

Before progressing far, the original scope of this paper was broadened to include certain eminent entomologists connected perhaps with museums, or systematists who though perhaps not holding official positions as entomologists, nevertheless, like Cresson, have made notable contributions to our literature.

In the early days of entomology in this country, it should be remembered that institutions for higher education were few; the system of state colleges which now covers the whole country like a net of lace work has been entirely developed within the past fifty years. Few of our agricultural experiment stations are more than twenty-seven years old. Nearly all of the colleges then in existence were of the classical type; scientific thought and action were just awakening.

It is not strange, therefore, to find that many of the early entomologists were not college graduates, though some of them studied for a time at one or more of the existing institutions. I shall take a few minutes of your time to speak of some of these early workers as well as some of the later ones who have passed from us.

Dr. Thaddeus William Harris, who was the first great economic entomologist of this country, graduated from Harvard University in 1815, and received his M.D. in 1820.

Thomas Say, often called the father of entomology in America, was not a college-trained man.

Dr. B. D. Walsh, first state entomologist of Illinois, graduated from Trinity College, Cambridge, England. Doctor Fitch graduated from the Vermont Academy of Medicine in 1829, and Le Baron also had the degree of M.D. and was probably a graduate of a medical college but I have not been able to find any definite record to that effect. Doctor Le Conte received an M.D. from the College of Physicians and Surgeons, and Doctor Horn from the University of Pennsylvania.

Professor A. S. Packard graduated from Bowdoin college in 1861, and later received the degrees of M.D. and Ph.D. W. H. Edwards, S. H. Scudder and F. H. Snow graduated from Williams College in the respective classes of '42, '57 and '62.

Professor F. L. Harvey graduated from Iowa Agricultural College in 1872; E. A. Popenoe from Washburn College in 1876; D. S. Kellicott from Syracuse University; M. V. Slingerland from Cornell University in 1892, and W. G. Johnson from Stanford University in the same year, though having previously studied at Cornell, and at Ohio State University.

Messrs. Thomas, Uhler, Lugger, Lintner, John B. Smith, and J. A. Grossbeck apparently received no college training, though Thomas, Uhler, Lintner and Smith were given honorary degrees.

Among the older workers yet with us Professor Chas. H. Fernald studied at Bowdoin College, receiving an M.A. in 1871; Professor J. H. Comstock graduated from Cornell in 1874. Dr. Geo. Dimmock of Springfield, Mass., graduated from Harvard in 1877. Samuel Henshaw and E. T. Cresson were not trained in colleges though Henshaw received an honorary A.M. from Harvard in 1903.

The card catalogue upon which this paper is based contains 306 names. Following Dr. Howard's arrangement in grouping them according to the part of the country in which the colleges are situated and adding Dr. Howard's figures for comparison, the results are as follows:

	Outside of Federal Service	Federal Service [1]	Total
From colleges in the Eastern States	117	113	230
From colleges in the Central States	121	63	184
From colleges in the Western States	28	31	59
From colleges in the Southern States	15	23	38
Total American Institutions	281	230	511
Total Foreign Institutions	3	12	15
No colleges	22	18	40
	306	260	566

Of course the efficiency of the entomological worker depends far more upon the personal equation of the man than it does upon his college training. No college course can quite take the place of actual experience in field and laboratory. The fact that many entomologists without college training have become eminent, simply means that these men had the other necessary qualifications and succeeded in

[1] Figures taken from paper of Dr. L. O. Howard, Jour. Econ. Ent., Vol. VII, page 277.

COLLEGE TRAINING OF ENTOMOLOGISTS

Name of Institution	Not in Federal Service					Federal Service[1]	Grand Total
	Student	Bachelor's Degree	Master's Degree	Doctor's Degree	Total No. Men		
Alabama Polytechnic Institute		1			1	2	3
Allegheny College						2	2
Amherst College		1		1	1		1
Augustana College		1	1	1	1		1
Baker University	1				1		1
Baldwin University		3			3		3
Beloit College						1	1
Bowdoin College		1	1		2	1	3
Brooklyn Polytechnic Institute		1			1		1
Bucknell College	1				1	1	2
Buchtel College	1				1		1
Butler College	1				1		1
Campbell College		1			1		1
Clark University		1	1	2	2	2	4
Clemson College	4	1			5	1	6
Colgate College		1	1		1		1
College of Physicians and Surgeons				1	1		1
Colorado Agricultural College	1	5	1		7	10	17
Columbia University	1		1	1	2	2	4
Connecticut Agricultural College		5			5	1	6
Cooper Medical College					1		1
Cornell University	20	24	11	14	63	26	89
Dartmouth College		3			3	1	4
Delaware Agricultural College						1	1
De Pauw University		1			1		1
Florida Agricultural College						2	2
Georgia State College of Agriculture		1			1		1
German American Normal College	1				1		1
German-Wallace College		2			2		2
Harvard University	6	7	2	5	18	7	25
Hillsdale College		1			1		1
Illinois State Normal University	2				2		2
Iowa State Agricultural College		8	6		9	1	10
Iowa State University	1		1		1	4	5
Iowa Wesleyan University		1			1		1
James Milliken University		1			1		1
Jefferson Medical College						1	1
Johns Hopkins University	2			3	5	1	6
Kansas State Agricultural College		6	5		9	5	14

[1] From Dr. Howard's paper, Jour. Econ. Ent. Vol. VII, 279.

COLLEGE TRAINING OF ENTOMOLOGISTS—*Continued*

Name of Institution	Not in Federal Service					Federal Service [1]	Grand Total
	Student	Bachelor's Degree	Master's Degree	Doctor's Degree	Total No. Men		
Kentucky State University	1				1	1	2
Keuka College	1				1		1
Knox College		1	1		1		1
Lafayette College		1			1		1
Maryland Agricultural College	1	2	1		4	4	8
Massachusetts Agricultural College	1	25	4	7	27	36	63
Michigan Agricultural College	2	10	6		12	7	19
Middlebury College		1			1		1
Mississippi Agricultural College						3	3
Montana Agricultural College	1				1	1	2
New Hampshire Agricultural College		3	1		4	2	6
North Carolina Agricultural College	2				2	1	3
Ohio Northern University		1			1		1
Ohio State University	6	18	10	2	33	17	50
Ohio Wesleyan University						1	1
Oklahoma Agricultural College	1	1			2	1	3
Ontario Agricultural College		2			2	6	8
Oregon Agricultural College		1	1		2		2
Otterbein University		2			2		2
Pennsylvania State College						5	5
Pomona College		3			3	2	5
Princeton University		2	1		3		3
Purdue University		1			1		1
Randolph-Macon College						1	1
Rutgers College		2	1		2	1	3
South Dakota Agricultural College		2	1		2		2
Stanford University	1	6	2	2	8	7	15
Swarthmore College		1			1		1
Syracuse University		1			1		1
Texas Agricultural College	1	1			2	2	4
United States Military Academy	1				1		1
University of California		5	2	1	8	1	9
University of Chicago	1		1		2	2	4
University of Colorado	1	1			2	1	3
University of Idaho						2	2
University of Illinois	3	8	2	6	15	5	20
University of Indiana		4	3	1	5	1	6
University of Kansas	2	13	10	1	17	5	22
University of Louisiana						2	2

[1] From Dr. Howard's paper, Jour. Econ. Ent. Vol. VII, 279.

COLLEGE TRAINING OF ENTOMOLOGISTS—*Continued*

Name of Institution	Not in Federal Service					Federal Service [1]	Grand Total
	Student	Bachelor's Degree	Master's Degree	Doctor's Degree	Total No. Men		
University of Maine		1	1		2	1	3
University of Michigan	1				1	1	2
University of Minnesota	1	3	2		5	2	7
University of Missouri		5			5		5
University of Montana						1	1
University of Nebraska	4	4	1		8	7	15
University of Nevada					1	1	2
University of North Dakota						1	1
University of Pennsylvania	1	2		4	6	6	12
University of South Dakota						1	1
University of Tennessee		1			1	2	3
University of Texas		2	1		3	2	5
University of Utah						3	3
University of Washington		1	1		1	2	3
University of West Virginia						2	2
University of Wisconsin	1	1		1	3	1	4
University of Vermont		1			1		1
Ursinus College		1			1		1
Utah Agricultural College		3			3	2	5
Vanderbilt University	1				1		1
Virginia Polytechnic Institute		3	2		3	4	7
Wabash College	1	1			2		2
Washburn College		1	1		1		1
Washington & Jefferson		1			1		1
Washington University (St. Louis)						1	1
Wesleyan University	2	1			3		3
Western Reserve University	1		1		2		2
Williams College	1	5	2		6		6
Worcester Polytechnic Institute	1				1		1
Yale University	3	1	1	3	8	5	13

spite of the lack of it. With it their success would have been even greater.

Realizing that men frequently receive their undergraduate training at one institution, then go to another for graduate instruction; that some attend colleges but do not graduate; that it would be of interest to learn which institutions conferred the bachelor's, master's and doctor's degrees possessed by our entomologists, the above arrange-

[1] From Dr. Howard's paper, Jour. Econ. Ent. Vol. VII, 279.

ment was finally adopted in the list of colleges and the number of entomologists who have sprung from them.

If we combine the number of different men with the similar figures given last year by Dr. Howard for the Bureau of Entomology, as has been done in the last two columns in the table, a better general survey of the subject will be obtained, despite the fact that duplications undoubtedly occur. These statistics are given in the accompanying tables.

Of the institutions attended by the entomologists discussed in this paper, the Massachusetts Agricultural College leads in the number of 25 bachelor's degrees conferred. Cornell follows with 24; Cornell has given fourteen doctor's degrees, Massachusetts Agricultural College seven: As regards the master's degree, Cornell has conferred eleven, Ohio State Univeristy nine, and four have been given by the Massachusetts Agricultural College. In the number of entomologists who have studied for a time without receiving a degree; Cornell also leads with twenty, and is followed by Ohio State University with eight. Cornell also is far in the lead, in the number of different entomologists who have studied within her walls. The following institutions lead the others in the number of entomologists receiving instruction there:

	Men outside of Federal Service	Federal Service	Total
Cornell University	63	26	89
Mass. Agricultural College	27	36	63
Ohio State University	33	17	50
Harvard University	18	7	25
University of Kansas	17	5	22
University of Illinois	15	5	20
Michigan Agricultural College	12	7	19
Colorado Agricultural College	7	10	17
Stanford University	8	7	15
University of Nebraska	8	7	5

In the years to come it will be even more essential than in the past that the entomologist receives a good undergraduate college training as a foundation upon which to build the superstructure of his professional life work.

It is particularly gratifying, today, to learn that so large a number of institutions are engaged in supplying the need.

PRESIDENT H. T. FERNALD: If there is no discussion on this paper, we will now adjourn.

Adjournment 4.30 p. m.

Morning session, Tuesday, December 29, 1914, 10.00 a. m.

PRESIDENT H. T. FERNALD: The meeting will please come to order.

VICE-PRESIDENT HERRICK: I move that the discussion of the presidential address be deferred until later in the session. Carried.

PRESIDENT H. T. FERNALD: The first paper on the program will be read by Mr. A. G. Ruggles.

LIFE HISTORY OF OBEREA TRIPUNCTATA SWED.

By A. G. RUGGLES

Division of Entomology, Department of Agriculture, University of Minnesota

On June 14, 1911, the Superintendent of Parks of St. Paul, Minnesota, asked for help in diagnosing and combating a pest on the elm which was new to him. All the trees along one of the finest avenues in St. Paul were found with numberless dead leaves hanging from terminal twigs. The ground was strewn with leaves, reminding one of the fall season. In order to keep the lawns and boulevards in shape, the leaves had to be raked up each day and the insect was proving a nuisance if not a serious pest.

No adult insects capable of doing this damage were seen then nor upon careful search later. As the eggs found seemed quite fresh, it is possible that the beetles may have been working at night or that they were all through ovipositing and had disappeared. In the spring of 1912, no adults nor egg-laying injuries were seen. Owing to a temporary absence from the state in 1912–13, no adult insects causing the damage have been taken in the field, up to the present time. The literature available gave only two references to an insect that might have been responsible for this damage.[1] These referred to *Oberea ulmicola* Chittenden. The work of this insect and the one in question corresponded very closely and since that time, in our notes, this insect has been referred to as *Oberea ulmicola*. Observations were made daily for a while, and weekly later, for the entire growing season of 1911 and the entire season of 1912. During my absence from the state in 1912–13, my assistant, Mr. George Peake, took care of the collected specimens and brought in new ones from the field from time to time. In January, 1913, under insectary conditions, and in May, 1913, under natural conditions, the larvæ pupated, the adults emerging ten days to two weeks later.

Since returning to the state, no opportunity occurred to study this

[1] Forbes, S. A. Twenty-fourth State Entomologist's Report of Illinois, 1908, Bull. Ill. State Lab. Nat. Hist. Vol. VII, Art. 1, pp. 10 and 11.

collected and reared material until November of the present year, when the beetles were sent to Dr. Chittenden for identification. He pronounced the beetle to be the common *Oberea tripunctata* (Swederes). The literature on *O. tripunctata* until a few years back referred only to the work of the insect on raspberry and blackberry. Hence, I surmise, according to a statement of Dr. Chittenden's, these were really references to *O. bimaculata* (Oliv.). In 1908, Forbes [1] mentions this species as being found working on elm and in 1911 as working on dogwood. As this seems to be a new pest for Minnesota and as the life-history differs from that given by other observers, it seemed worth while to bring it to your attention.

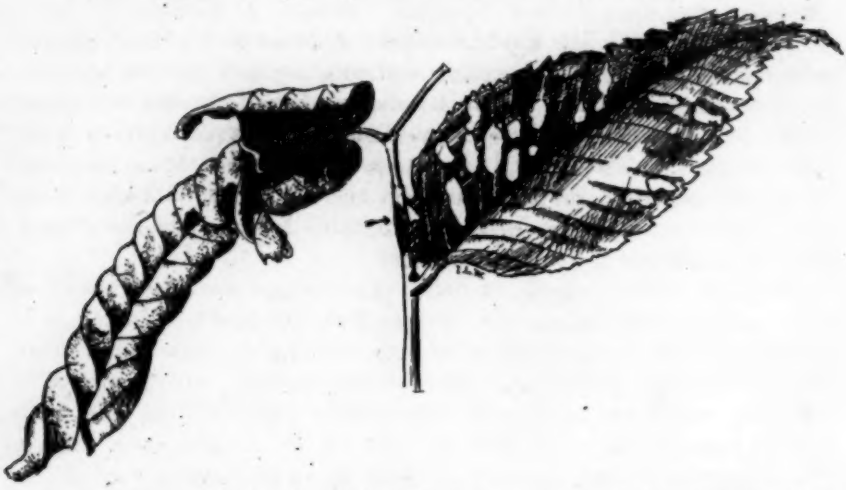


Fig. 1. Shows work done by adult of *Oberea tripunctata* and the relative position of the egg. (Somewhat reduced.)

The Work of the Adult

The elm leaves, as shown in Fig. 1, were found on infested twigs and at the time the work was suspected to be that of the beetle in question. (This of course has never been proved.) Many twigs were found completely girdled in several places, evidently due to more than one beetle ovipositing. Below the last complete girdle, there was seen a double irregular slit, evidently made by the two ovipositors not quite coinciding, which extended 7 to 8 mm. down the stem to an incomplete girdle. Half way between these two points, the egg was inserted under the edge of the slit bark.

[1] Forbes, S. A. *Loc. cito.* and Twenty-sixth State Ent. Rep., Illinois, 1911.

The Egg

The egg is 2½ mm. long and 0.7 mm. in width; cylindrical, with round ends, smooth and of a yellowish tinge. Many eggs were found on one stem, each in its characteristic position, but all the eggs between the complete girdling next the main stem and the end of the twig soon perished. Fig. 2 shows the methods of placing the egg in the twig. The arrow in Fig. 1 and the x in Fig. 2 show the position of the egg.

Larvæ and Work

The eggs began to hatch June 21, just one week after my first observation, and no more eggs were found after June 28. The entrance hole of the larva was just below the lower end of the egg. In the majority of the burrows examined, the larvæ first tunneled upward and later returned to continue the burrow downward. Many perished by emerging at the girdled end. This may be due to their inability to turn around after emergence or possibly due to attacks of an enemy. Along the burrow, at short intervals, 6 mm. or more, the larva made holes through the bark or through an aborted bud out of which it pushed its borings. Up to October 30, 1911, the longest burrow made was 75 mm. The majority of the burrows, however, were much shorter. The larvæ at this time measured 5 mm. in length and had a head measurement of 0.6 mm. This, according to the theory of head measurement, would place the hibernation period in the third instar. By the last of July, 1912, practically all the larvæ had reached the last stage, having a head measurement of 1.2 mm. In September, 1912, some burrows were six inches and more in length and in the terminal portion of the burrow, the larva hibernated. In Minnesota, therefore, it takes two years for this beetle to complete its life-cycle.

In wood-boring insects, it is very difficult to find moulted skins in the burrows and practically, therefore, impossible to tell the number of instars. I have been doing some work on the head measurement of these wood-boring insects, and a few species of wood-boring beetle larvæ in all their stages have been examined. The head measurement appears quite constant for a given period which we believe would correspond to the length of an instar, and therefore, this measurement is preferred to merely length measurements which are sometimes given with descriptions of larvæ. For *Oberea tripunctata* larvæ, the following measurements and descriptions are given:

First Instar.—Head measurement, .36 mm.; length, 0.8 mm. to 2.6 mm. The young larvæ are lemon-yellow in color, at times having an orange cast. The anterior part of the head and mandibles are a very

Fig. 2. Showing detailed work of adult and position of egg (x4)
Fig. 3. A young larva soon after hatching (x6)
Fig. 4. A lateral view of a larva showing the ventral and dorsal ridges (x6)
Fig. 5. A pupa (x6)
Fig. 6. A ventral view of an adult (x6)

dark brown; the labium is light-colored and seemingly not chitinized. The posterior area of the dorsal portion of the head is light-yellow, resembling the thorax in color. A larva just after hatching is only a little over twice as long as the width of the widest part. The segments are closely set together. Later, as the larva grows, these separate, as in the other instars. The shape is typically Cerambycoid; the thoracic segment immediately caudad of the head having the largest diameter of all the segments, while the following segments gradually decrease in size until the penultimate segment is distinctly smaller and the anal segment distinctly smaller than the preceding. On a distinct anal ridge on the caudal portion of the first thoracic segment is a somewhat triangular area in which are short hairs or bristles giving the appearance of shagreening. This area is very noticeable in all the succeeding instars. Ten transverse rows of short bristles are seen in each shagreened area. The third, fourth and fifth rows are composed of larger bristles while the last few rows are very small and almost inconspicuous.

A number of short, stiff hairs arise from the head and on the lateral margin of each thoracic and abdominal segment are found three to six hairs somewhat longer than those found on the head. The posterior margin of the caudal segment is beset with numerous hairs. Toward the end of the instar, the segments are plainly distinguished and dorsal ridges as described in instar number two begin to appear.

Second Instar.—Head measurement, .45 mm., length, 3 mm. to 5 mm. The last three or four rows of inconspicuous bristles in the shagreened area of the thorax are curved. On the dorsal surface of each of the abdominal segments, particularly the second to the sixth, there is a distinct, flattened, ridge-like area. These look like tubercles in a side-view. (Fig. 4.) The hairs are the same as for the first instar.

Third Instar.—Head measurement, .66, length, 4.5 mm. to 10 mm. Besides the characteristics mentioned for the other instars, the segments of the larvæ have a decided moniliform appearance, due to the prominence of the dorsal ridges and the swollen lateral margins of the segments. The ventral surface of each segment has also a prominent ridge.

Fourth instar.—Head measurement, .8 mm., length, 10 mm. to 22 mm. The dorsal ridges are very regular and on the flattened surface, indistinct shagreening, divided into two distinct lines, each separated by a median line, may be detected. The ventral protuberances have minute tubercles and hairs on the surface.

Fifth Instar.—Head measurement, 1.2 mm.; length, 19 mm. to 25 mm. The other characters are very similar to those in fourth instar.

Pupa

Pupæ were found only in the second year after the eggs were found. In the field, they were normally found in May. In two or three weeks, the adults emerged. They lie naked in the extremity of the burrow. Length, 13 mm., width, 3 mm.; color, uniformly white, at first, later changing to light yellow. The compound eyes are dark-brown quadrangular areas on the ventral part of the head, close to the base of the antennæ. On the anterior portion of the head, between the base of the antennæ, are two sets of hairs, each set containing two hairs, one hair usually twice the length of the other. The distal half of the mandibles are light brown in color and the entire area between the mandibles is filled with the sub-triangular clypeus.

The antennæ are quite prominent, extending to the base of the hind femora when they curve forward to the base of the front legs.

Adult

Like all the species of Oberea, this is a slender form; length, 12–14 mm., width, 1.5–2 mm. The head, antennæ, and middle and outer and inner margins of the elytra are black. The central area of the elytra, running three-quarters of its length, is usually orange in color. The head, elytra, and thorax are feebly punctate, the pits on the elytra being the more conspicuous. A dense gray pubescence is found over all these regions. The thorax is yellow or orange in color, and on the dorsal region has three black callosities. The smaller median one lies in front of the scutum, while the two larger spots lie one on each side of the median line.

One of the distinguishing characters of the species is the banding of the ventral segments. The thoracic segments are black with perhaps the exception of the part of the metathorax where the yellow legs are attached. The first segment of the abdomen is yellow, the next two are black, the following segment is yellow, while the caudal segment is black. A slight overlapping of the segment areas by the yellow bands is often noticed. The yellow portions on some specimens are often replaced by dark orange. The proximal portions of the legs are yellow or orange, the tips being dark brown or black.

Parasitism

As mentioned previously in the paper, many larvæ perished while in the burrow toward the cut end of the twig, due possibly to some predaceous parasite. Many times in later stages, the burrow was found empty with evidences that the larvæ had been attacked by

parasites. For various reasons none were reared. In hunting for larvæ, the presence of empty burrows was very noticeable, so much so that in the notes taken in 1911–12, it was estimated that there must be from 50 to 80 per cent of parasitism.

Preventive Measures

At the time of the outbreak, it was recommended that all the infested twigs should be cut out and burned, or that if the tree was trimmed and pruned properly, the insects would be disposed of. This was done, to a large extent, and as we heard of no outbreak in 1913, the trimming must have been effective.

Mr. J. M. Aldrich: I would like to ask Mr. Ruggles if he reared any parasites?

Mr. A. G. Ruggles: We did not rear any parasites. I was away so much that it was impracticable to attempt to do this.

President H. T. Fernald: We will now listen to a paper by C. Gordon Hewitt.

THE BROWN-TAIL MOTH IN CANADA

By C. Gordon Hewitt, *Ottawa, Can.*

(Paper not received in time for publication.)

President H. T. Fernald: This paper is now open for discussion.

Secretary A. F. Burgess: Last spring, through the courtesy of Dr. Hewitt, I had an opportunity to visit New Brunswick and Nova Scotia and go over a part of the infested territory. This made it possible for me to see the difficulties under which his men were obliged to work during the long cold winter which is usually accompanied by deep snow.

The territory is not provided with good transportation facilities, particularly in New Brunswick, and this makes it very difficult for the men to do the work.

I was greatly impressed with the conscientious and hard work which had been done by the field men in that territory. Dr. Hewitt has indicated the distribution of the brown-tail moth in Nova Scotia and New Brunswick, the outer line representing the territory found infested in the winter, 1913. In the spring of 1914, we made a trip through the southern part of New Brunswick from St. John to St. Stephens; thence to Woodstock, New Brunswick, and Houlton, Maine, and returned to St. John.

Another day was spent in the Annapolis Valley in Nova Scotia. During this trip, I did not see a brown-tail moth web, although a great many susceptible trees were hastily examined. This indicates that good work had been done by the field men. It also indicates the difference in condition of infestations in that territory from what is found in some of the New England States.

Dr. Hewitt mentioned a series of experiments that are being carried on by his assistants to determine the relation of temperature to the successful hibernation of brown-tail caterpillars. Last winter, particularly in the northern part of the infested territory in New England, large numbers of the brown-tail moth caterpillars died in the webs. Although we do not know accurately the exact causes, we believe that temperature and humidity were very important factors.

For several years, some experimental work of this sort has been carried on by the Bureau of Entomology and by some of the states, particularly New Hampshire, and some general conclusions have been reached in regard to the effect of temperature on hibernation. The difficulty is the impossibility of securing accurate temperature records so as to determine the degree of temperature which will cause winter killing and whether fluctuations are important in this respect.

We have come to the conclusion in our work that it is necessary to have a continuous temperature and humidity record at the locations where periodical collections are made during the winter. Experiments are being conducted this year along this line, stations having been secured at approximately sea level and at an altitude of about one thousand feet. Continuous records are being taken at these stations and collections of webs secured periodically and examined to determine the condition of the caterpillars.

Hearty coöperation has existed between the Bureau of Entomology and the Dominion Entomologist in connection with the introduction of parasites into New Brunswick and Nova Scotia. In cases where the parasites of the gipsy moth and the brown-tail moth attack more than one host, it is possible to attempt a colonization of the parasites before these pests become established. This work, however, is largely experimental.

We have coöperated during the past summer with Professor Webster, who has charge of the Cereal and Forage Crop Insect Investigations for the Bureau of Entomology. He supplied a man during the summer to make collections and we have rendered such assistance as was possible in securing *Compsilura* and *Calosoma* for shipment to New Mexico in order to test the value of these species as an enemy of the range caterpillar.

We have colonized parasites in all the New England States this

year and have carried on very successful coöperative work with Professor O'Kane in New Hampshire.

MR. W. E. BRITTON: Knowing as we do the general tendency of the brown-tail moth to spread toward the north and east, I think it would be interesting if Dr. Hewitt would explain why the southern end of Nova Scotia is not generally infested.

MR. C. GORDON HEWITT: Answering these inquiries as they are made, I would like to say in reference to Mr. Burgess' remarks concerning the effect of humidity, that we find in Nova Scotia, judging from our own results along here (indicating on the map), that the average minimum temperature is higher than the minimum temperature in the interior of New Brunswick. Owing to the occurrence of greater humidity along the shore of the Bay of Fundy than in New Brunswick, we find a greater percentage killed at a higher minimum temperature. It is very evident that humidity exercises a very great influence along this region in Nova Scotia (indicating the Annapolis Valley), where the fogs are effective.

In regard to Dr. Britton's inquiry as to why the central region of the eastern part of Nova Scotia is not infested, I cannot explain that except in the absence of the chief food plants. This portion of Nova Scotia (indicating) has a very peculiar geological formation. It is largely coniferous and unsettled except here and there. Such occupied lands are usually infested, but we never found any webs in the scouting trips which have been made across the forest and lake region. The large flight in 1913 resulted in the infestation of the southeastern region including Shelburne County. We had observations made on Sable Island by the lighthouse people, who collected and submitted for examination all the moths they could capture at the light. We did not find a single brown-tail moth but we found moths of the army worm in these collections.

A MEMBER: What is the minimum temperature in New Brunswick?

MR. C. GORDON HEWITT: The minimum temperature in New Brunswick in the infested region last year, I think, was, so far as our records show, 30.5 degrees below zero at St. Stephens. We found in Nova Scotia that one hundred per cent of the larvæ were killed at a number of points where the temperature went to 22 degrees below.

A MEMBER: In New Hampshire as high as 95 per cent have been found alive at a temperature of 30 degrees below.

MR. C. GORDON HEWITT: We found them in New Brunswick with minus 30.5 degrees Fahrenheit temperature.

PRESIDENT H. T. FERNALD: We will now pass to the next paper by Mr. C. H. Hadley, Jr.

CONTACT SPRAYS FOR BROWN-TAIL CATERPILLARS

By C. H. HADLEY, JR., *Durham, N. H.*

(Paper not received in time for publication.)

SECRETARY A. F. BURGESS: Mr. Siegler, one of Professor Quaintance's assistants, carried on some experiments with insecticides to determine their effect on brown-tail moth caterpillars. I think his results might be interesting.

MR. E. H. SIEGLER: Under the direction of Mr. Quaintance, experiments with various miscible oils, alone and combined with nicotine sulphate, were conducted in Maine and Massachusetts during the season of 1913. The first test of the spray materials was directed against the brown-tail nests and later, when the larvæ were emerging from their nests in maximum numbers, a second spray application was made.

A few days following the spraying of the nests, the nests were cut and removed to the laboratory at Melrose Highlands, Mass. Although the nests had been thoroughly drenched with the spray materials, the larvæ emerged apparently unaffected. The structure of the winter nests makes it difficult for a spray material to penetrate sufficiently to kill the insects within. Furthermore, with large trees, it is difficult to thoroughly drench the nests unless a large amount of spray material is used.

As soon as the brown-tail larvæ were emerging from their nests in maximum numbers, they were sprayed with the miscible oils and nicotine solutions. This work was carried out both in the field and laboratory. In all instances the larvæ were thoroughly drenched. The results were not satisfactory. Owing to the hairy covering of the larvæ, the spray materials stood in small drops at the extremity of the hairs, apparently not coming in actual contact with the body of the larvæ. The only material which gave satisfactory control was pure kerosene. This could not well be used owing to the probable injury it would cause to the host plant.

MR. C. H. HADLEY, JR.: The experiments which we conducted were on small trees and in some cases we used eight quarts of material to a single tree. So far as possible, we aimed to drench the caterpillars in order to give the insecticide a good opportunity to penetrate. It is doubtful if we would use as large an amount of material in our spraying operations.

PRESIDENT H. T. FERNALD: Is there any further discussion?

MR. T. B. SYMONS: I move that we now take up the discussion of the President's address. Carried. Vice-President Herrick takes the Chair.

VICE-PRESIDENT HERRICK: Personally, I was much impressed with two points—one the emphasis laid upon the desirability of more exhaustive studies on the life-history and habits of insects. That I think has been emphasized by certain results obtained lately. I think many of us have felt that the extensive work of Professor Slingerland on the peach-tree borer precluded the necessity for any further work on this pest. I understand, however, that further work on the habits and life history of this insect by Professor Scott has enabled him to develop a method of control which is very efficient. This emphasizes the need of further study of the life-history and habits of other insect pests.

Another point emphasized was more careful studies of insecticides. Undoubtedly Dr. Felt has brought together a good deal of proof that miscible oils are injurious to trees under certain conditions, but during the last two or three years we have applied miscible oils to a great many trees at certain stages, and in no case found injury to these trees. Unfortunately, we do not know just the conditions that bring about injury in some cases and no injury in other instances. This, it seems to me, emphasizes the need of more careful and thorough study of insecticides.

I hope there will be further discussion of this address.

MR. J. G. SANDERS: I was deeply interested in one point brought out by the President regarding the necessity for very careful study of all stages of the life history of economic insects, which was emphasized by the speaker. In our work on the control of the onion maggot in Wisconsin during the past four years, and in working up the literature relating to the control of this species, we have noted a large number of remedies recommended for the control of the onion maggot, numbering I think over sixty. Practically all of these remedies have been recommended for the destruction of the egg or larva already placed on or adjacent to the onion plant, while a few methods were intended as repellents against the adult fly. It seems that no effort had been put forth to kill the adult fly before oviposition.

In a careful study of the life-history of the onion maggot it was determined that a period varying from 10 to 14 days elapsed after the emergence of the adult female before fertile eggs were deposited. It seemed that if an effective means of killing the adult fly during this period could be obtained, it might possibly prove an effective control for this pest. We have determined an effective poison bait spray which works satisfactorily with the adult fly and seems to be a very practical and effective control for the onion maggot, in some cases to the extent of 95 per cent to 98 per cent, while a check plot adjacent was injured to the extent of 75 per cent.

The poison bait spray used is composed of five grams of sodium arsenite dissolved in a gallon of boiling water into which is thoroughly mixed a pint of New Orleans molasses. This bait is applied as a coarse spray of large drops once a week in strips across the onion field throughout the summer. The results show almost perfect control at a cost not to exceed 50 to 75 cents per acre for the summer treatment.

The results of this treatment serve to emphasize this point in the address of our President relating to a more careful and thorough study of all stages of our economic insect pests with a view to finding the most vulnerable stage in their life history. I really believe that more attention should be given to the destruction of the adult insects wherever it is feasible.

MR. E. P. FELT: I think most of us would heartily endorse what our President conveyed in his message of yesterday, and while I do not care to discuss the address as a whole, I would like to refer to two matters, namely, the study of life zones and the prediction of insect outbreaks.

We are located next to Massachusetts, and if we had desired to do so, could have brought a map of New York State showing very nearly a duplication of the conditions described in Massachusetts. More than that, we are using this general knowledge of life zones in our recommendations and are finding in that connection some interesting and important economic applications. We began studying life zones in a general way in 1898, and while we have not given a large amount of time to the investigation, it is a matter which has been constantly in mind. At the outset we made some temperature calculations, and, among other things, found probable extensions of the upper austral zone almost to Lake George and Lake Champlain. We have in New York State, certain insects rather closely confined to this zone. This is fairly well marked in the case of the San José scale and the elm-leaf beetle. Five or six years ago the latter began to be injurious at Glens Falls (altitude 300+ feet, soil sandy), a locality considerably north of the usual recognized boundary of the upper austral life zone. At that time I gave an opinion in the belief that this locality lay in the transition zone, to the effect that there was a fair chance of the insect not proving injurious. Subsequent developments showed that this insect was injurious not only there but also at Ticonderoga (elevation about 200 feet) on Lake Champlain.

An important point in this connection is that the northern extension of the upper austral life zone and of insects associated therewith, may be brought about in two ways. In the first place we have a great prolongation northward of land only a little above sea level, and in the second, and fully as important in some respects, is that north from

Albany there is an extensive sandy area. Land of this character absorbs large amounts of heat in the daytime and gives it off at night, thus preventing during the active growing season, dangerously low night temperatures and permitting a greater extension of the upper austral life zone than would be possible otherwise. For example, the well-known southern *Sphecius speciosus* has been taken for several years in succession on the sandy plains west of Albany.

We have endeavored to trace the connection between climatic conditions and insect outbreaks, because we realize that if we could say to our farmers: "Certain weather conditions are favorable or unfavorable for the development of injurious insects," we had something of practical value, provided it was not carried too far. We are satisfied that abnormally low temperatures continued late in the season mean favorable conditions for outbreaks of apple plantlice.

Another interesting matter is in connection with the elm-leaf beetle. In 1912 and again in 1914, in a little village (Nassau) fourteen miles from Albany and having an elevation of about 400 feet, we have had a large number of elms under personal observation. In the early spring of both seasons, elm-leaf beetles appeared in numbers rather abundantly and deposited many eggs, a condition preliminary to extensive and serious injuries, which latter failed to develop as expected. We carefully examined the temperature records for the month of June, covering a period of ten years, and found in the case of the two years mentioned above, a marked decrease in the average temperatures during the middle ten days of the month, namely June 11 to 20 inclusive. This is a time when, under normal conditions, in our latitude, egg-laying should be at its maximum. It is necessary, in our estimation, that there should be a coincidence between the period of low temperatures and the time when oviposition is at its height, otherwise these vital functions, such as the deposition of eggs, their hatching and the development of the young larvæ, may simply be delayed rather than inhibited. Under our conditions it would appear that when the sum of the maximum and minimum temperatures (F.) for a ten-day period for or about the middle of June does not exceed 1,250, the probabilities are that egg-laying will be checked and that an unusual mortality will occur in both eggs and young grubs. This is simply a tentative proposition and is a line of investigation which must be followed with caution.

A little farther east from Nassau, at an elevation of approximately 800 feet, and surrounded by ridges running close to 2,000 feet, there seems to be relatively little injury from this insect, presumably due to the fact that the minimum spring temperatures prevent a normal and vigorous development.

This may possibly be applied more generally as soon as we recognize the vital factors and realize the connection between the period of maximum oviposition and adverse climatic conditions.

VICE-PRESIDENT HERRICK: I would like to ask Dr. Felt if he knows the altitude of Ticonderoga?

MR. E. P. FELT: Approximately 200 feet.

MR. C. GORDON HEWITT: I should like to add a word of praise to what has been already said regarding Dr. Fernald's presidential address, so full of suggestion and admirable counsel. We find especially in Canada the truth of his remarks in regard to the necessity of working out more carefully and completely the life-histories of many known injurious insects. We have not had many workers in the past and have found it necessary to rely very largely on the results of investigations obtained in the United States. We are now finding on investigation that in many instances we are mistaken and that we have not been advising the best methods in the control of some of our common insects; therefore, I appreciate very fully the significance of the statement that further intensive work is necessary as all will agree.

I was much interested in the second part of the address, in regard to the new fields of work, especially those which concern us, for example, relation of temperature to insects. The factors governing the distribution of insects concern us very closely, especially in regard to the question as to what insects now occurring and injurious in the United States are likely to find congenial conditions for injurious activity when they arrive in Canada. I think from the fact that we have not found so many destructive insects as we might be led to expect would appear to indicate that certain species have reached the northern limit of their destructive powers.

I was especially interested, too, in the President's remarks on the necessity of our becoming more familiar with the relation of food to reproduction and longevity. There was one point that Dr. Fernald did not mention (he naturally could not cover the whole ground of new work), and that is the desirability of securing information covering or bearing on the relations of the Chemotaxis. The recent excellent results obtained by Messrs. Dean and Hunter and others in the use of poisoned bran, made attractive by lemon and other fruits, is a long step forward. Dr. Tragardh in Sweden and Mr. Howlett in India have given us much information regarding the attractiveness of various chemical substances. It is certain that this line of inquiry will open up a new field of immense practical value in the control of insect pests.

We all appreciate, I am quite sure, the great importance of a general knowledge of foreign insects. As is well known to all the members

here, the British Empire has been endeavoring to overcome our lack of knowledge of the insects of foreign countries, and in 1912 the Imperial Bureau of Entomology was formed in London, one of the first and chief functions of this Bureau being to collect information regarding insect pests and to distribute that information to the various British countries and possessions. Most of the members in this meeting are able through the *Review of Applied Entomology* published by the Imperial Bureau to make use of that information. This is one of the chief steps in the direction of making us better acquainted with the insect pests of foreign countries.

MR. W. E. BRITTON: I have been much impressed with the President's address, and many of the points which he has mentioned are certainly deserving of further study. In regard to the elm-leaf beetle, however, I may state that formerly I believed as he does—that the danger of its doing much injury in the higher altitudes was slight. During the past few years, however, I have changed my mind. During 1914, especially, it has caused serious injury in Winsted, Norfolk, Canaan and other points about 1,000 feet above sea level. On the other hand, there was very little injury along the coast where the insect has caused serious damage for more than 20 years.

With these introduced insect pests, it seems to me that we must allow them considerable time in which to find their economic level; that we may find it necessary to revise our first opinions because conditions may modify the habits or severity of a pest. It is hardly safe to draw conclusions or to go very far in generalizing about the distribution causes, until the species has been present for a long time and its status as a pest has become established.

SECRETARY A. F. BURGESS: A great many statements have been made that certain insects, particularly foreign species, will become a pest in this country only in certain regions and on particular food plants and this information has been published quite frequently.

In the case of the brown-tail moth, for instance, it was, years ago, very common on elms in the worst infested region in New England. At the present time the number of webs found on elm trees is rather small. It was generally stated a number of years ago that the elm-leaf beetle was a city insect but the fact is that we find it in the country in New England almost everywhere elm trees grow. The same has been published concerning the leopard moth in regard to its being a shade tree or city insect, but it is very possible that this pest may later on do great injury in woodland.

It seems to me, as Dr. Britton has said, you cannot lay down a law concerning new insects until we have had considerable experience with them.

VICE-PRESIDENT HERRICK: If there is no further discussion, we will proceed with the program. President H. T. Fernald resumes the Chair.

PRESIDENT H. T. FERNALD: The next paper on the program will be read by E. P. Felt.

FUMIGATION FOR THE BOX LEAF MINER

By E. P. FELT, *Albany, N. Y.*

The Box leaf miner, *Monarthropalpus buxi* Lab., has become well established on Long Island and is seriously injuring ornamental Box hedges. The badly infested plants drop many of their leaves and soon become very scraggy and unsightly. The conditions are such that a considerable expenditure would be justified for control work in many instances, and a series of experiments were therefore started to ascertain the possibility of destroying the Dipterous maggots within the mines, since direct control methods against the midges or methods of preventing oviposition were not specially promising. The adults fly the latter part of May and there appears to be but one generation annually.

A series of preliminary tests were made with twigs of Box kept in vials and exposed to the action of various gases in ordinary two-quart fruit jars. Under these conditions fumigation with 5, 10, 15 and 20 drops of carbon bisulfid for twenty-four hours resulted in the maggots being pronounced dead within three days without, so far as could be observed, appreciable injury to the foliage. The time was cut down to five hours, 15 drops of carbon bisulfid were used and the larvæ were apparently all killed and the foliage uninjured; 30 drops were used with an exposure of three and one-half hours with similar results.

Two teaspoonfuls of carbon bisulfid to a ten-quart bell jar were used for the fumigation of entire plants, the larvæ being killed after a two-hour exposure, while a one-hour treatment with one and one-half teaspoonfuls of the insecticide did not destroy the maggots. We are of the opinion that one teaspoonful to five quarts of space for a period of at least one hour, we prefer at present to extend the time to two hours, will kill the larvæ without injury to the plant.

Similar tests were conducted with carbon tetrachloride, and while the maggots were affected, the gas was not nearly so effectual, and after a period of twenty-four or forty-eight hours the larvæ were active and apparently normal. There was no appreciable injury to the foliage.

The most interesting tests were with C. P. ammonia. It was used

at the rate of 5, 10, 20 and 30 drops to a two-quart fruit jar, the exposure being 15 and 60 minutes. The treatment was fatal to the maggots and there was also serious injury to the foliage. The gas penetrated the mines readily and caused the collection of moisture. The latter was probably drawn from both the plant and animal tissues and resulted in an early collapse of the larvæ, especially where the larger amounts of ammonia were employed. The mines in the treated foliage had a strongly pungent ammonia odor for two to even seven days after the fumigation. It is possible that by using smaller amounts of this chemical we could secure the destruction of the larvæ without serious injury to the plants. Our preliminary experiments, however, indicate the probability of more or less damage to the foliage.

Flake napthalene used at the rate of one-half teaspoonful to a two-quart jar and giving an exposure of five hours, resulted in the larvæ becoming quiescent and eventually recovering. There was no injury to the plant. The twenty-four hour fumigation gave practically the same results.

Potassium cyanide, 95 per cent was used at the rate of one dram with one-fourth of an ounce of sulphuric acid and three-fourths of an ounce of water to 27 cubic feet, the exposure being for 15 minutes. This strength is practically one-half that recommended for fumigating nursery stock, namely, one ounce to two hundred cubic feet of space. This treatment killed some of the larvæ and did not injure the foliage.

Owing to conditions it was impossible to supplement these tests by experiments under field conditions.

VICE-PRESIDENT HERRICK: I would like to ask Dr. Felt if he tried any contact sprays like Black Leaf 40 on the foliage.

MR. E. P. FELT: We tried contact leaf sprays in the course of the experiments and got absolutely no results on box leaf miner. It is a thick leaf and the membrane over the mine is rather thick.

MR. E. N. CORY: In Maryland, there was found one infestation of this insect on a hedge on a large estate. The hedge is about 600 feet long and practically two-thirds of it is infested. We have attempted some preliminary experiments with cyanide but were unsuccessful in our fumigation. We tried Black Leaf 40, one part to 500 parts of water with the addition of two pounds of fish-oil soap and were unsuccessful with that. We have planned to continue on this hedge with contact insecticides. We will also follow Dr. Felt's work and try some of his fumigation experiments on this hedge.

MR. E. P. FELT: One more statement entirely outside of the scope of the paper. Professor Stene of Rhode Island reports fairly good

results with contact insecticides such as kerosene emulsion or whale oil soap solution, applied when the midges are beginning to emerge.

MR. P. J. PARROTT: This discussion is of great interest to me because there occurs in New York an insect which is a miner of the foliage of certain kinds of sour cherries. On the basis of the work which has been done with the elm-leaf miner, I attempted to combat the pest by the use of various contact mixtures, including nicotine preparations, soaps and oil emulsions. With none of these insecticides were we able to kill the leaf-miner. Finally we tried fumigation with hydrocyanic acid gas which was very effective. If the insect becomes a serious pest, it may be necessary to resort to this treatment, but for the present we are recommending the removal and destruction of infested leaves and cutting out of hawthorn plants in the immediate vicinity of the orchards.

MR. W. C. O'KANE: Our experience to some extent agrees with that of Mr. Parrott. The subject is attractive only to an insecticide man who has some knowledge of the nature of the leaf. Apparently the leaf tissue in that case is of such texture that the substance will not penetrate.

PRESIDENT H. T. FERNALD: Experiments on the box leaf miner in Massachusetts on plants brought from Newport, R. I., gave no indication that Black Leaf 40 could penetrate the tissue, and experiments with that material proved practically a complete failure. Fumigation was not considered, because of the conditions under which the box is grown, at least at Newport, where there are long hedges of it or rows of it hundreds, and perhaps in some cases even thousands, of feet continuously. It seemed almost impracticable to apply fumigation methods under such conditions of growth; but when Black Leaf 40 failed as a contact application there seemed to be nothing left to be done with the limited material available for experimental work.

MR. E. N. CORY: Have any experiments been tried with poison sprays?

MR. E. P. FELT: Not to my knowledge. We know almost nothing as to the effect of such sprays upon the larvæ or adults.

PRESIDENT H. T. FERNALD: The next paper will be presented by C. P. Gillette.

NOTES ON SOME COLORADO APHIDS HAVING ALTERNATE FOOD HABITS

By C. P. Gillette and L. C. Bragg

Chermes cooleyi Gillette and its var. *coweni* Gillette

This species and its variety may be said to live all the year through, upon both the Engelmann and blue spruces for one form, and the Douglass fir for the other. The lice upon these trees now are all in first instar stage, none of them having passed through the first moult. Those upon the Engelmann and blue spruces all have their setæ thrust into the bark of the twigs where they will develop and deposit eggs in the spring, and these eggs will hatch the second generation which will produce the cone-like galls at the ends of the twigs. Early in July these galls will give out the adult winged lice of this form which will all fly to the Douglass spruce to lay their eggs upon the needles. The young from these eggs hatch, and without growing in size or moulting, will remain upon the needles with their setæ inserted along the median line until the following spring. In the spring these lice become mature and lay eggs which hatch into a brood of lice, some of which remain upon the Douglass spruce, while others go to the needles of the Engelmann and blue spruces where they deposit the eggs for the form above described that remains over winter. So each year the two forms of this species migrate, one to the Douglass and the other to the Engelmann and blue spruces. The Douglass spruce should not be planted near Engelmann and blue spruces in a yard or park.

Pemphigus betæ Doane

This insect is a native of the Rocky Mountain region, and is a rather general feeder upon the roots of plants during the summer season. The goosefoot family, especially sugar beets, garden beets and mangel wurtzels, are favorite food plants. Among our native plants and weeds, we have found this louse common upon the roots of *Aster*, goldenrod (*Solidago*), *Iva xanthifolia*, and lambsquarter, *Chenopodium*. While it does not seem necessary for this insect to take on a fall migratory habit, still, as near as we have been able to estimate, about one-half of the lice acquire wings during September and October and leave their summer hosts and fly to the cottonwoods. Apparently, only a small percentage ever find the desired host. In beet-growing sections it is common for these lice to fly in countless millions, like great swarms of ants, for more than a month during the warmer portion of the day. Since the fall of 1910 we have known that this louse migrates to the cottonwoods,[1] in large numbers in the fall to deposit

[1] See twenty-third Annual Report Colorado Experiment Station, p. 98.

the sexual males and females, but not until the past summer has it been definitely determined in what form this species appears upon the cottonwoods early in the summer. Mr. Asa C. Maxson, in charge of the experimental work in the Longmont district for the Great Western Sugar Company, who has been a collaborator with us in some plant louse studies, has succeeded the past summer in determining the form of gall produced by this louse upon the cottonwood leaves and in successfully colonising the lice in large numbers upon the beets and in rearing from these colonies, the sexuparæ. We extract from a report by Mr. Maxson upon his work as follows: "On May 4th . . . the larvæ were located upon the upper side of the leaf which was light in color where the larvæ were feeding, and showed a depression which, as it grew larger, entirely inclosed the insect and formed a gall on the under side of the leaf. This form of gall is produced by *Pemphigus balsamiferæ* Williams."[1]

Many observations by the writers tend to confirm the conclusions reached by Mr. Maxson whom we congratulate on the excellent life history work that he has done on this insect, which is one of the worst pests that the sugar beets have to contend against in the Rocky Mountain States.

It seems probable that Parker, in JOURNAL OF ECONOMIC ENTOMOLOGY, 1914, page 139, hit upon the correct gall for this louse, but referred to it on page 141 as by *populicaulis* Fitch, which produces a globular gall upon the petiole of the leaf. Furthermore, this gall occurs in the Middle and Eastern States, while *P. betæ* seems to be strictly a Western species.

Pemphigus populicaulis Fitch

Winter host, *Populus* species; alternate host unknown.

Pemphigus populitransversus Riley

Winter host, *Populus* species; alternate host unknown.

Pemphigus populiramulorum Riley

Winter host, *Populus* species; alternate host unknown.

Pemphigus ulmifusus Walsh

Winter and early summer host, *Ulmus* species; alternate host unknown.

Mordwilkoja vagabunda Walsh

Winter host, *Populus* species; late summer host unknown.

Asiphum pseudobyrsa Walsh

Winter host, *Populus* species; alternate summer host unknown.

Asiphum sacculi Gillette

Winter host, *Populus tremuloides;* alternate summer host unknown.

[1] Aphididæ of Nebraska, Williams. University Studies, Vol. X, No. 2, 1910.

Thecabius populiconduplifolius Cowen

This species has *Populus occidentalis* for its over-winter and early summer host, and migrates to native species of *Ranunculus* for the later summer and fall months. Transfers between these host plants are readily made artificially and the lice do not all leave the *Ranunculus* in the fall, so that they may be found upon *Ranunculus* the year round. In fact, many lice having alternate host plants infest one of the food plants continuously, a portion of some brood acquiring wings and migrating to a different species of plant as an alternate host.

Prociphilus corrugatans Sirrine

Occurs commonly upon *Cratægus* species as a winter host; alternate host unknown.

Prociphilus alnifoliæ Williams

Occurs upon *Amelanchier alnifolia* as the over-winter host; the alternate host unknown.

Colopha ulmicola Fitch.

Occurs upon *Ulmus americana* as the winter host, and upon *Eragrostis* species during later summer and fall. The migrants returning during September and October to the elms.

Tetraneura graminis Monell

Occurring upon *Ulmus americana* as the winter host, and upon rice cut-grass, *Lersia oryzoides*, during the summer and fall.

Schizoneura americana Riley

The sexuparæ of this species fly in great numbers to the trunks and lower limbs of the American elms during the months of September and October each year. The sexual males and females are deposited in any hiding place beneath bits of bark where it will be difficult or impossible for Coccinellids to reach them. The eggs laid by these sexual females hatch into stem-mothers the following spring that locate upon the young opening leaves and start the generations that cause the leaf-curl gall that Riley figured as the gall of *americana*. The spring migrants resemble the return migrants of the fall, and neither should be confused with the fall migrants from the apple (*lanigera*) which are bark feeders and which differ markedly from *americana* in both antennal and wing characters. So, while it seems certain that this species has an alternate food plant upon which it lives during the latter part of the summer, we have not been able to locate it.

Schizoneura rileyi Thomas

This species, also occurring on the elm, but always as a bark feeder like *lanigera* of the apple, deserves mention for the purpose of avoiding confusion with the other elm species. It is quite distinct from the other species of the genus mentioned and probably has no alternate

food plant as we have taken the sexuparæ, the true sexual forms and the eggs of this species on elm trees where colonies have been present throughout the summer.

Schizoneura cratægi Oestlund

Like *lanigera*, this is a bark feeder and occurs upon the bark of both the limbs and roots of native *Cratægus* in Colorado. It also gives off fall migrants which are much longer winged than *lanigera* and consequently more nearly like *americana* of Riley, but we do not know that its alternate host plant has been definitely determined.

Schizoneura lanigera Hausman

This species inhabits the apple throughout the year. During August and September sexuparæ migrate in large numbers from the apple, but we have never been able to find these migrants establishing themselves upon other host plants, and we have never found return migrants early in the summer coming to the apple. We are inclined to the opinion that a regular alternate summer host for this species is not positively known. We feel certain that sexuparæ from the apple do not migrate to the elm and produce either the elm leaf-curl gall, *Schizoneura americana* of Riley, or the leaf-cluster gall or rosette of the elm which was included by Riley in his species *americana*, and which we consider, for morphological and other reasons, to be a distinct species. We regret that, for Colorado at least, we cannot accept the conclusions of Dr. Patch that *Schizoneura lanigera* upon the apple has anything to do with the production of either the elm leaf-curl or the elm leaf-cluster as described by Riley. A full discussion of this matter would be too lengthy to incorporate here.

Anoecia corni Fabricius

This species winters in the egg state in large numbers upon the stems of dogwood, *Svida stolonifera*, in Colorado. The lice completely desert the dogwood early in the summer and go to unknown plants.

Rhopalosiphum rhois Monell

This louse is fairly common upon *Rhus trilobata* as a winter host in Colorado. During the summer and fall months it occurs upon many of the grasses where it seems to prefer the flower heads. We have taken it from timothy, wheat, oats, barley and native species of *Elymus*.

Amphorophora howardii Wilson

This species was described in *Canadian Entomologist* for 1911, page 59, and was referred to under this name by Davis in *Canadian Entomologist* for 1914, page 165. It seems to be a synonym of *rhois*.

Rhopalosiphum lactucæ Kaltenbach

This is a common species on *Sonchus oleraceus* during the summer

months, the stems and flower heads often being literally covered with the lice. During September and October the males and the sexuparæ desert the *Sonchus* and go to species of *Ribes*, especially *aureum* and *vulgare*, where the sexual females are deposited, and, after fertilization, deposit the over-winter eggs.

This is undoubtedly the *Rhopalosiphum ribis* Koch, which Buckton figured on Plate 39, Volume II, of his British Aphididæ along with the leaf galls of *Myzus ribis*.

Rhopalosiphum hippophæs Koch

The summer form of this louse inhabits species of *Persicaria* exclusively, so far as we have been able to determine. In the fall, the sexuparæ migrate to species of *Elæagnus*, *Shepherdia* and *Hippophæ*, which are closely allied plants, and deposit the sexual females which later deposit their eggs about the buds. The males follow when the females are about half grown.

The over-winter hosts for this species also serve as winter hosts for *Phorodon galeopsidis* Kalt., and *Myzus braggii* Gill. As a paper by the senior author of these notes, dealing with the synonomy of this group, is expected to appear soon in "Annals." We will not enter into a discussion of the matter here.

Rhopalosiphum pastinacæ Linneus

This species becomes very abundant upon *Pastinaca* and some other *Umbelliferous* plants during the summer months in Colorado, and in the fall goes to the honeysuckles belonging to the genera *Lonicera* and *Zylosteum*. Both males and sexuparæ migrate.

Rhopalosiphum capreæ Kaltenbach

This species has been much confused with *Pastinacæ* in the past because it also goes to the *Umbelliferæ* as summer hosts, and in a general way the two species are similar in appearance. Under the microscope, however, *capreæ* is easily distinguished by its caudal horn appearing like a second tail, and its winter host is always a species of willow. For a fuller discussion of these species see JOURNAL OF ECONOMIC ENTOMOLOGY for 1911, page 320. These species could well be placed in different genera.

Hyalopterus arundinis Fabricius

Occurs abundantly upon plum and prune as over-winter hosts, and migrates in early summer to Reed Grass, *Phragmites communis*, from which the males and sexuparæ return to *Prunus* in the fall.

Aphis bakeri Cowen

This species winters freely upon both the cultivated apple and *Cratægus*. It migrates early in the summer to the white and red clovers.

When the plants are large or somewhat protected we have found this species spending the winter upon the leaves of red clover. While this is a common louse in Colorado, and we have done a large amount of collecting for plant lice, we have never found it established upon any herbaceous plant outside the clovers.

Aphis setariæ Thomas

A rather common species infesting the plum as a winter host in Colorado, and going to the grasses for the summer. We have taken it most commonly during the summer upon *Panicum crusgalli*, but also upon *Setaria* sp.

Aphis viburnicola Gillette

The sexuparæ of this species come very regularly in large numbers to the snowball, *Viburnum opulus*, every fall. Soon after the creamy white sexual females have begun to develop, the males follow and later the eggs are deposited about the buds and axils of small twigs. The young of the stem-mothers all get wings and leave the snowball bushes, but we have never been able to locate the alternate host where the summer months are spent.

Aphis avenæ Fabricius

We have, at least, two or three species of *Aphis* which occur upon both the apple and some of the grains and grasses that belong to what we have designated as the *avenæ* group. At present, we prefer to pass this group by as we are not able to satisfy ourselves as to just which of these species *avenæ* really is.

Myzus bragii Gillette

This species spends the winter upon *Elæagnus* and migrates to the Canada thistle, *Carduus arvensis*, as the summer host. It seems probable that there are additional summer hosts, but we have not been able to locate them.

Myzus persicæ Sulzer

This species passes the winter upon pit fruits, peach, plum and cherry with an apparent preference for the peach. The spring migrants go to a very wide range of summer hosts, some of the most important of which are the cabbage and other cruciferous plants, potatoes, tomatoes, beets, species of *Rumex*, *Dianthus*, etc. This louse is another species that is able to continue its existence from one year to another in protected places out of doors and in greenhouses.

Phorodon humuli Schrank

Winters on the plum, and in Colorado we have taken it in some numbers upon plum foliage throughout the year. The regular summer host is the hop.

Macrosiphum granaria Kirby

The eggs of this species are deposited upon rosebushes in the fall. Early in the summer the migrants go to oats and wheat, and probably to some other grains and grasses.

Macrosiphum dirhodum Walker

This species, like the preceding, has the rose as a winter host, and goes to the grains and grasses during the summer.

It seems a surprising thing that, after so much study of the life habits of the Aphididæ, there are still so many species having the habit of alternating their annual host plants, where only one of the winter hosts is known. There is still abundant opportunity for much good research work along this line.

PRESIDENT H. T. FERNALD: We will now take up a paper, the title of which failed to be printed on the program, by Mr. E. B. Blakeslee.

A MECHANICAL PROTECTOR FOR PREVENTING INJURY BY THE PEACH BORER

By E. B. BLAKESLEE, *Washington, D. C.*

(*Abstract*)

This paper briefly discussed the feeding habits and behavior of newly hatched peach borer larvæ. The point was emphasized that, in addition to the fact that large numbers of eggs are deposited about the crown of the tree, larvæ hatching from eggs deposited on trunk and branches instinctively migrate downward and begin their work below the surface of the soil. When an impenetrable barrier was placed at the crown of the tree, the larvæ made no attempt to enter above it. By the use of a cone-shaped tarred paper protector, extending out for eight inches to one foot from the base of the tree, and sealed with a viscous substance, it was found possible to entirely exclude the larvæ from the tree. The protectors were cut out in circular form with a hole in the center somewhat larger than the trunks to which they were to be applied. To serve as a support for the protector the earth was pulled up to the tree, slightly, making a small mound, the base of which was slightly below and the top slightly above the surface of the ground. The protectors were then brought tightly about the tree and fastened, the contact with the tree and the laps coated with a sticky sealing material and the earth pulled back over the edges. Field experiments showed that these protectors were able to maintain

their impenetrable character under field conditions. Photographs of the protector were exhibited.

MR. E. B. BLAKESLEE: Mr. Scott has secured very good results with a device which is essentially the same as the one described.

A MEMBER: I would like to inquire if in these experiments anything like cement was used which would harden in the soil?

MR. E. B. BLAKESLEE: We have not used cement or gas-tar mixtures for fear of injuring the trees. I do not think the cement would give good results.

A MEMBER: Some years ago we tried a series of experiments to test mechanical protectors of various sorts as a remedy for the peach borer. Those that we tried usually caused considerable injury to the trees.

MR. E. G. TITUS: In Utah, we find that peach borers attack the trunks and branches as well as the crown of the tree. This makes it difficult to use a mechanical protector.

MR. WILMON NEWELL: To me this is a very interesting paper. I think a glance at these photographs will convince any entomologist that the right principle is being correctly applied. We were working on this same insect in Texas a couple of years ago and tried to make application of the same principle. We even went so far as to make paper protectors but were not successful in sealing them to the trunks of the trees.

I am familiar with the work done along this line by Mr. Scott the past summer, and mentioned by Mr. Blakeslee. I happen to know that Mr. Scott's protectors, very similar to these but made in a different way, were placed on the trees early in the season. The results were such as to convince me that a method of control for one of our worst fruit tree pests has been developed. We should not let this matter pass without getting all the information we can and I would like to ask if Mr. Scott will give us the results of his work along this line.

MR. W. M. SCOTT: I was not aware that this subject would come up for discussion and therefore did not come prepared with notes on the results of my experiments, except such as I happen to have in this little pocket note-book.

I began experiments for the control of the peach tree borer while State Entomologist of Georgia, about 15 years ago, and have since continued to work on this problem as a peach grower. After trying numerous washes I concluded, as did Mr. Blakeslee, that this was not the right method of procedure. The habit of the newly hatched larvæ to crawl down the trunk of the tree and enter the moist tender bark below the surface of the soil furnished the clue to the solution of the

problem. In order to prevent injury from this insect, it is necessary to prevent the larvæ from reaching the underground portion of the tree. This is easily accomplished by encircling the trunk at the ground with a flexible soil-covering mat which must be impenetrable to borers and impenetrably sealed to the tree.

Last March I began to devise a protector that would fulfill the requirements and finally adopted a tarred felt mat, 16 inches in diameter, with a hole in the center to conform to the diameter of the tree and a slit from the hole to the outer edge. The soil is first mounded somewhat around the tree and the protector placed over this mound. The slit edges are lapped and glued together with a viscous material and the protector is sealed to the tree with the same material, completely filling all openings, so that it is impossible for the borers to reach the soil without crawling away from the tree beyond the outer edge of the protector. The viscous material for effecting an absolute sealing to the tree is an essential feature of the protector. I tried several substances and found the best to be a sticky preparation consisting, for the most part, of a residuum from the partial distillation of coal tar.

Beginning on June 9, 1914, I applied protectors to 250 peach trees in my orchard at Hancock, Md., and the results were perfect except where the mat was not properly sealed to the tree. An examination on October 2 showed that of 40 Belle trees provided with protectors, 28 were entirely free from borers, 7 had one each, 4 had two each and 1 had sixteen. The protectors had broken loose from the trees where a poor paste was used and this accounts for the successful entrance of the borers in these trees. It also emphasizes the necessity of maintaining an absolute seal between the protector and the tree. An average of 12 borers per tree was found in 15 unprotected trees nearby.

In a block of three-year-old Elbertas 20 treated trees were examined and 16 of them found free from larvæ. The protectors had partly cracked loose from the other four trees, admitting from 1 to 5 borers. Twenty untreated trees in an adjacent row were examined and found to be nearly ruined by borers. There was an average of 28 borers per tree and 5 trees averaged over 40 per tree. This gave the protectors about as severe a test as they could be subjected to.

Now in justice to myself and others I should admit that, on September 30, I applied for a patent on this method of protecting trees against borers.

MR. T. J. HEADLEE: Mr. Blakeslee, what did you use for sealing the protector?

MR. E. B. BLAKESLEE: I used "tanglefoot," it was the best thing I could find. I find the tanglefoot seems to retain efficiency under ordinary conditions. It doesn't dry out.

MR. T. J. HEADLEE: We have used tanglefoot for two seasons and while there was no injury the first season, during the second season the bark has died beneath the tanglefoot and the trees have perished. Our applications were made on a very small surface of the tree.

MR. A. L. QUAINTANCE: I want to congratulate both Mr. Scott and Mr. Blakeslee for this discovery—independent discovery, as I happen to know. It appears to be a true case of parallel development. I am inclined to believe that the development of this tree protector marks the finish of a first-class insect pest which, up until now, has never been satisfactorily controlled. Of the many species of pernicious insects with which the orchardist has to contend, none have been more troublesome for a longer time than the peach borer. It is noted that Mr. Scott has applied for a patent for this protector. Should this be granted to him, the bureau will naturally discontinue further work along this line. It may contribute to its more speedy adoption by peach growers that it should be pushed by private interests, and I feel perfectly sure that no claims will be made by Mr. Scott as to its merits which, in his judgment, are not fully warranted. I certainly hope that it will be used by peach growers everywhere who are troubled with the peach borer.

MR. W. E. RUMSEY: In our experiments at the West Virginia Agricultural Experiment Station against the peach tree borer we have been trying some penetrating substances which were sprayed on the base of the trees to determine if it is practical to destroy the young borers in this way. While the work has not been under way for a sufficient length of time to obtain definite results some interesting observations have been made. Two of the materials used for the purpose mentioned were avenarius carbolineum emulsion and "Orchard Brand" miscible oil (1–9). To apply the materials the soil was removed from the base of the tree, as is done in "worming," and the trunk sprayed from six or eight inches above the general surface of the ground to the bottom of the cavity made by the removal of the soil. After spraying the dirt was replaced. The materials were applied in October and the trees examined the following June. The check trees showed an average of about five borers to a tree; with the miscible oil treated trees the average was one borer per tree; and where carbolineum emulsion was used we found an average of less than one borer per tree.

When applying the carbolineum emulsion night came on before the work was completed and when we returned the next morning three dead borers were found on the bark of the last tree treated the previous evening. One had worked its way completely out of its burrow and the other two were half way out. This indicates that the emulsion

had penetrated the bark and the borers had tried to escape. In the use of the two substances mentioned there was no apparent injury to the trees.

SECRETARY A. F. BURGESS: I would like to ask Dr. Headlee if both old and young peach trees were injured by tanglefoot? We are using large quantities of this material each year and seldom notice any injury, although we very rarely apply this material to peach trees.

MR. T. J. HEADLEE: The tanglefoot was applied both to young trees with thin tender bark and to old trees with rough heavy bark in bands about eight inches wide, beginning two or three inches below the surface of the soil and extending five or six inches above. The young trees first exhibited injury, but sooner or later practically all succumbed.

PRESIDENT H. T. FERNALD: If there is no further discussion, we will take up a paper by George A. Dean and R. K. Nabours.

A NEW AIR CONDITIONING APPARATUS

By GEO. A. DEAN, *Entomologist*, and R. K. NABOURS, *Zoölogist, Kansas Agricultural College and Experiment Station*

Within the last ten years the influence of moisture and temperature on animal life has received considerable attention. It is not necessary to emphasize the value and the absolute necessity of accumulating data relative to this important phase of entomological and zoölogical work. The difficulty in this work has been to devise or to secure some sort of an air conditioning apparatus that would maintain a desired constant humidity and temperature within a reasonable degree of variation. Different individuals have devised various machines and incubators for this purpose, but to the knowledge of the writers they have all proved more or less unsatisfactory. For several years the departments of entomology and zoölogy of the Kansas Experiment Station have been building and experimenting with various moisture and temperature control apparatus. Last spring at the suggestion of Professor Potter, of the Engineering Division, it was decided to take the matter up with some air conditioning specialists. After conferring with several companies a contract was made with the Carrier Air Conditioning Company, of Buffalo, N. Y. The plan was to construct and install a machine that would automatically condition the air before it entered the breeding chamber, flow it into the breeding chamber continuously and at a rate that would make a complete displacement of the air at least every minute.

Just recently the air conditioning machine has been installed and

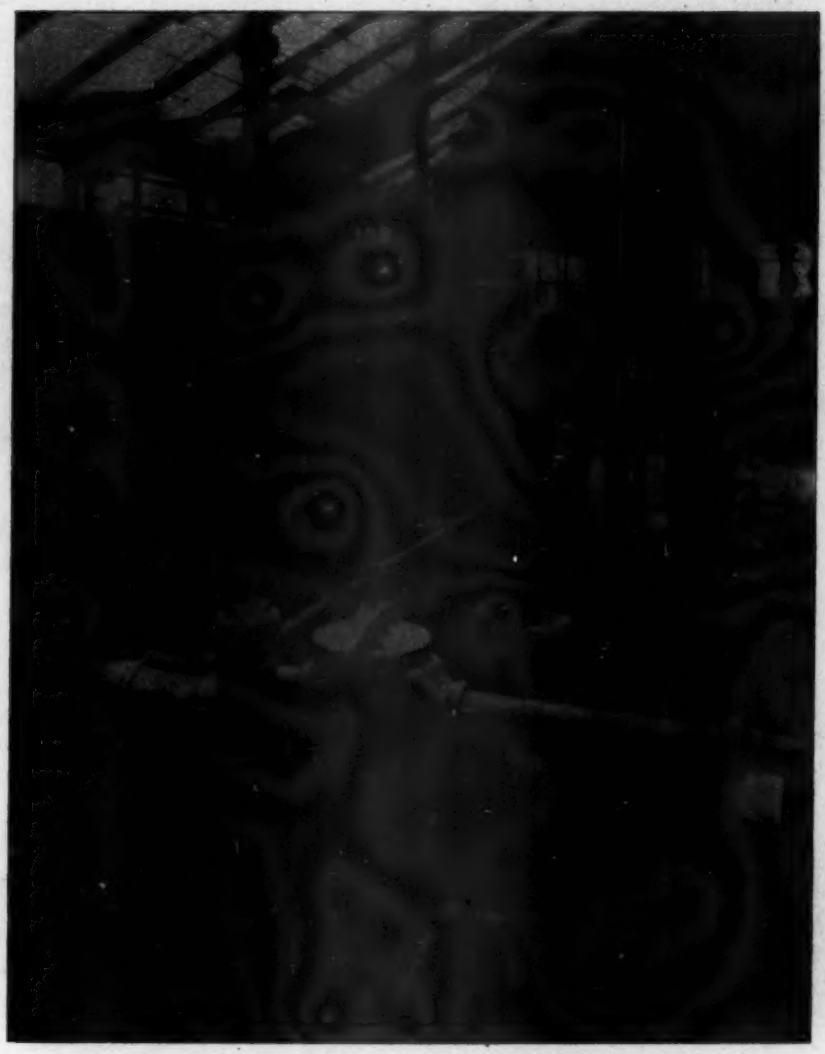
it is the object of the writers at this time to present the general arrangement of the apparatus, the principle of operation, and the moisture and temperature records maintained in the breeding chamber.

The spray chamber shown at A (Plate 1) is nine feet long and is provided with nozzle standpipes B, arranged in two groups or banks, placed about three feet apart, with the last bank three feet from the eliminator plates. The flooding of the eliminators is done by an independent set of nozzles shown at C across the top. These nozzles distribute the water over the washing surface uniformly. Valves shown at D outside of the spray chamber are provided on each bank of nozzles and also on the flooding nozzles over the washing surface, and thus either or both banks of nozzles can be closed to regulate the humidity. With both banks of nozzles closed, no appreciable increase in humidity of the air is produced. With one bank in operation (and the water recirculated without being heated) the humidity of the air will be increased about sixty per cent. With both banks of nozzles in operation, the humidity is increased about eighty per cent. If the water is heated the air leaves saturated. The banks of sprays can be opened or closed and the temperature of the water also varied as required.

Two water-tight inspection doors shown at E (Plate 1) are provided to allow easy access to the spray chamber. Beneath the entire washer and eliminator is a settling tank F, sixteen inches in height. A strong frame, built of angle iron, encloses the settling tank, to which it is firmly united, making a very rigid and substantial base to support the balance of the washer. The tank is provided with an automatic float valve, which controls the water supply and maintains a constant water level in the tank; an overflow valve G, which connects to the sewer and which prevents flooding the tank; a drain valve arranged under the bottom of the tank and which connects to the sewer, so all the water may be drawn off for cleaning.

The settling tank is divided into two compartments by a wire cloth strainer, through which the water passes before entering the suction of the pump H.

Connected to the passage just beyond the eliminator chamber is the air suction fan shown at K (Plate 1) propelled by a steam turbine L. This fan draws the air through the spray chamber of the air washer and humidifier, where it comes in contact with the atomized spray of water. The evaporation of a portion of the spray water humidifies the air and the amount thus evaporated depends upon the relative temperature of the water. Leaving the spray chamber, the air next passes over the washing surfaces of the eliminators and then over the stem of a graduated thermostat shown at M (Plate 1) placed in the passage just beyond the eliminators, so that it is exposed to the tem-



THE HUMIDIFIER AND AUTOMATIC CONTROLLING MACHINERY

A, spray chamber; *B*, nozzle standpipe; *C*, nozzle standpipe over the eliminators; *D*, valve for nozzle standpipe; *E*, water-tight inspection door; *F*, settling tank; *G*, overflow pipe; *H*, double suction centrifugal pump; *I*, spiro steam turbine with direct connected suction pump; *J*, pot strainer; *K*, suction fan; *L*, spiro steam turbine; *M*, graduated thermostat; *N*, ejector water heater; *O*, direct acting diaphragm valve; *Q*, compressed air storage tank; *R*, reverse acting diaphragm valve; *S*, safety relay; *T*, tempering or heating chamber; *X*, air duct leading from breeding chamber to spraying chamber; *Z*, automatic lubricator.

perature of the air leaving the washer, and its expansion or contraction is caused entirely by this temperature, and the variation due to its expansion is made to regulate this temperature. The water heater of the ejector type shown at N is placed in the suction line to the pump. The heater operates like a barometric condenser, so that the temperature of the spray water is varied by varying the amount of steam furnished to the ejector.

The diaphragm steam valve shown at O (Plate 1) is placed in the steam line which supplies the water heater. The valve is operated by compressed air from the graduated thermostat.

The air compressor shown at P (Plate 2) furnishes compressed air to the storage tank Q (Plate 1) at about fifteen pounds pressure. The compressor is driven by the same steam turbine L, that drives the air suction fan K.

The reverse acting diaphragm valve shown at R (Plate 1) is normally closed, but is opened by compressed air from the tank, passing through the safety valve S.

This method of control is extremely sensitive, as any variation in the air temperature passing over the stem of the graduated thermostat produces a change in the air pressure on the diaphragm steam valve, causing the valve to partially open or close, thereby producing a new water temperature. In only a few seconds this water is sprayed into the air, affecting its temperature, giving to it more or less heat in accordance with the requirements of the thermostat. This air in about one second passes over the thermostat stem, imparting to it the change in temperature.

The air then passes to the tempering or heating chamber T (Plate 1) to be heated sufficiently to maintain the required temperature and moisture. The heating chamber consists of six double-section steam radiators of the vento type, each having a radiating surface of sixteen square feet. The radiators are so constructed and so arranged as to distribute and heat the air uniformly before it flows into the breeding chamber. One or more or all six of the radiators may be used in accordance with the requirements of the air. The steam entering the radiators is automatically controlled by the graduated thermostat shown at U (Plate 2), placed in the breeding chamber. The entering air is evenly distributed in the chamber and flows over the stem of the thermostat. The expansion or contraction of the thermostat is caused entirely by this temperature and the variation due to its expansion is made to regulate this temperature. The diaphragm steam valve shown at V (Plate 2) placed in the steam line W that supplies the steam for the radiators, is operated by compressed air from the graduated thermostat in the breeding chamber. The thermostat produces

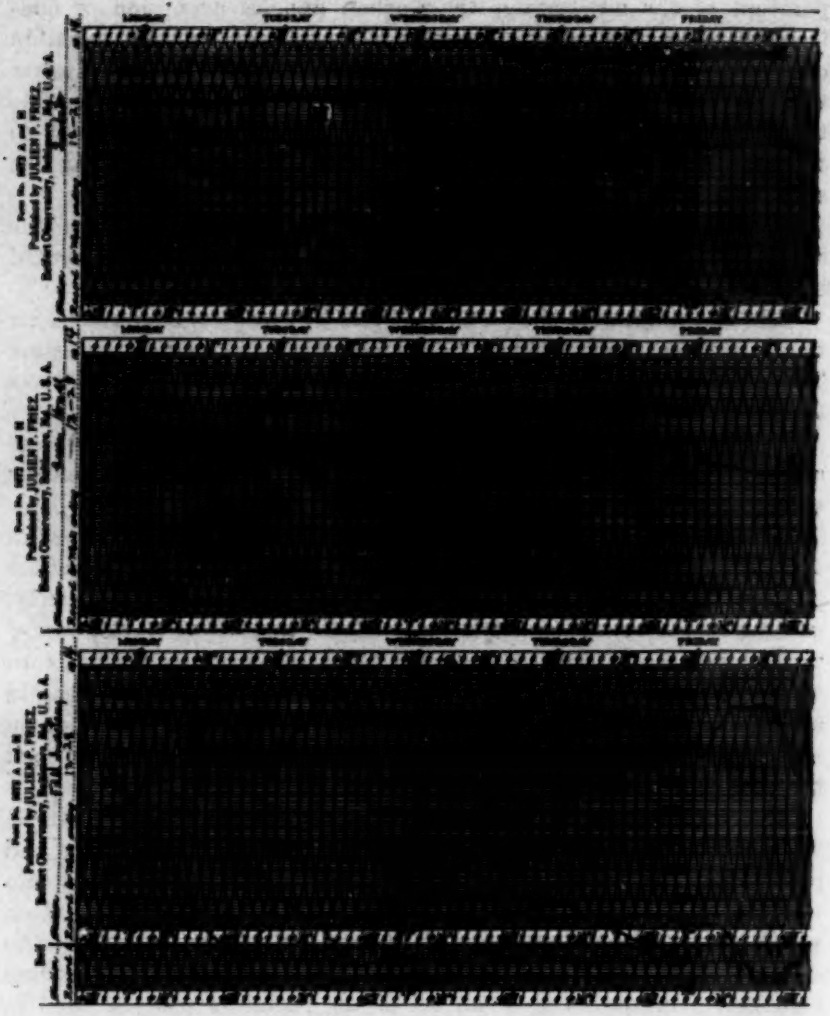


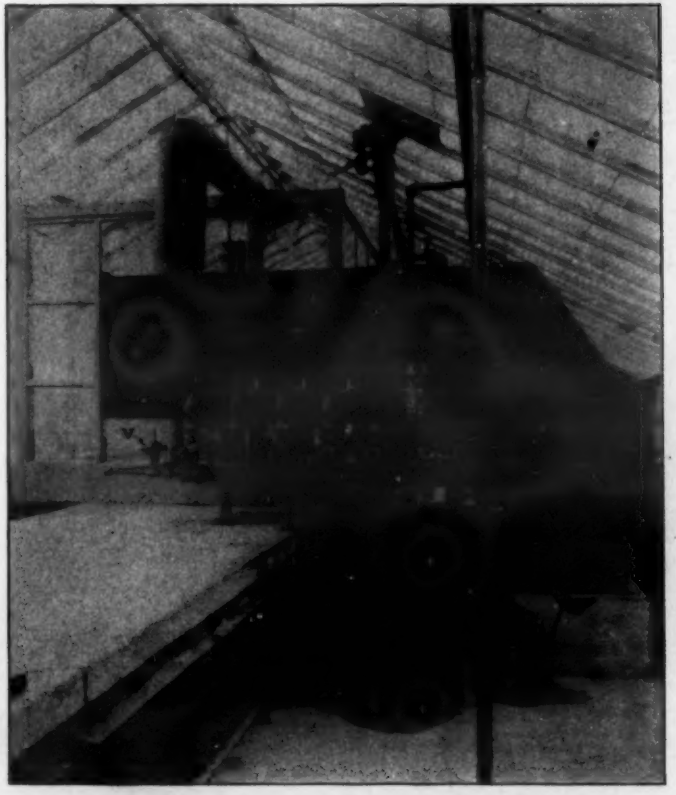
FIG. 8.—Charts showing the moisture and temperature control in the breeding chamber from December 21 to 9.00 o'clock December 26, 1914, compared with the humidity and temperature in the insectary and outdoors. *T*, temperature; *H*, humidity.

NOTE.—The temperature during the night of December 25 was ten degrees below zero. This air was brought directly into the spray chamber and in less than three seconds was passed into the breeding chamber at a temperature indicated by the chart.

LETTERING FOR PLATE 2.

K, suction fan; *L*, spiro steam turbine; *P*, air compressor; *T*, tempering or heating chamber; *U*, graduated thermostat; *V*, diaphragm steam valve; *W*, steam line; Y, air duct leading from heating chamber to the breeding chamber; *Z*, automatic lubricator.

BREEDING CHAMBER



HEATING CHAMBER AND CONTROLLING MACHINERY

See opposite page for explanation of lettering.

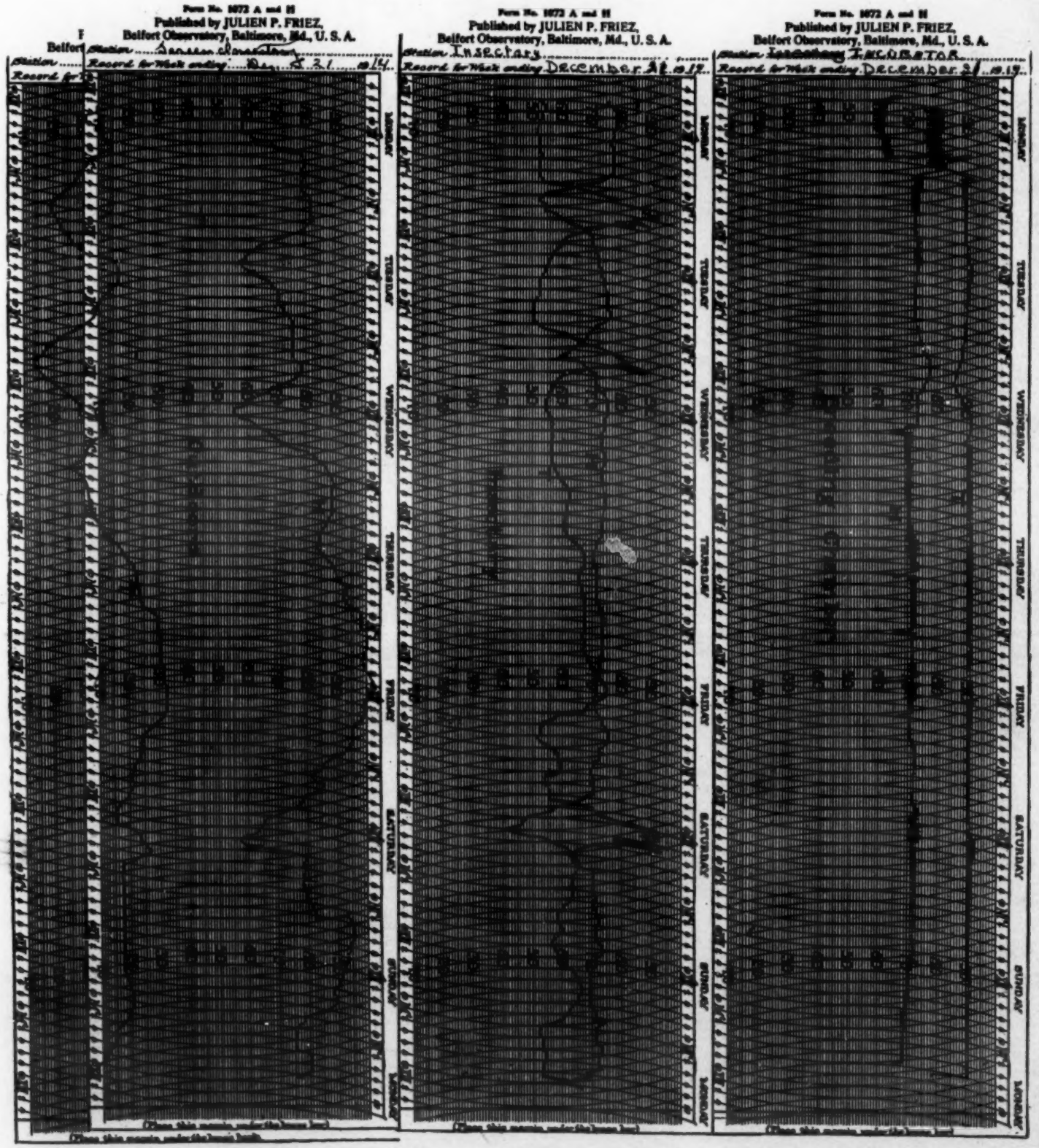


FIG. 7.—Charts showing the moisture and temperature control in the breeding chamber from December 14 to December 21, 1914, compared with the humidity and temperature in the insectary and outdoors. *T*, temperature; *H*, humidity.

NOTE.—Part of the time the cold air from outdoors was brought directly into the spray chamber.

a change in the air pressure on the diaphragm steam valve, causing the valve to partially open or close, thereby controlling the temperature of the heating chamber.

The breeding chamber (Plate 2) consists of a double glass-walled room, six feet wide, eight feet long, and seven feet high, with a small entering vestibule. A complete change or displacement of the air in the breeding chamber is produced every minute, the air flowing out at the bottom of the chamber and entering the spraying chamber by means of a large air duct shown at X. The outside air may also be brought in by means of a large air duct which comes in from the outside and enters the same chamber as the air duct coming from the breeding chamber.

We gratefully acknowledge complete support for this undertaking from Director W. M. Jardine. We are under special obligations to Mr. A. W. Bellomy, assistant in genetics, for much of the work and the whole of the supervision of the installment of the apparatus. We also desire to express our appreciation of the invaluable services of Prof. A. A. Potter and members of his staff in the Engineering Division and of Mr. A. E. Stacey, of Chicago, engineer for the Company.

MR. T. J. HEADLEE: Thinking that the members of this Association might be interested in a less expensive apparatus intended to control temperature and moisture, I will venture to describe one which I have recently devised. It consists of two small heating chambers under absolute control. The Freas Electric Incubators will serve well or a cheaper form can be made. Within each of the two chambers is placed an air-tight glass receptacle. By means of properly insulated tubes the two air-tight chambers are connected. By means of a faucet pump air from outside the building is sucked through the two chambers. In passing through the first incubator the air is heated to a given temperature and saturated with moisture by passing it through a series of waterfilled chambers. On entering the second chamber the air is heated to the temperature desired for the insect and given the proper degree of relative humidity. By raising or lowering the temperature of saturation, within reasonable limits, any relative humidity can be created and maintained. In course of rigid tests recently completed, two degrees of humidity were maintained for one week each. In an apparatus such as this the size did not permit the use of a thermo-hygrograph and it was necessary to resort to a modified form of the dew-point apparatus. If care be used in purchasing the chambers, it is possible to secure chambers at $100 to $125 a pair. No doubt further mechanical improvement

would lower the cost. With six pairs, costing from $600 to $750, six different temperatures could be maintained simultaneously and the response of an insect to temperature under specified moisture conditions determined in a short time. Furthermore, by the exclusion of light or the use of artificial light of known composition and known intensity, the disturbing influence of variable light could be eliminated.

The machine just outlined by Mr. Dean seems really to serve a different purpose and not to be capable, except as its units are multiplied or modified, of lending itself to the study of insect response to temperature and moisture. I say this because the number of chambers is so small that any close determination of response with it must involve the running of the temperature and moisture ranges of a single insect in several successive experiments, two degrees of temperature or moisture being studied at a time, thus introducing another complex variable. This apparatus does, however, provide a means of studying insect life-history under known conditions of temperature and moisture. It is also possible by use of smaller chambers within the larger ones to run simultaneously a sufficiently large number of temperature or moisture-response experiments to derive reliable data on which to base laws of response.

MR. G. A. DEAN: In the discussion of the air-conditioning apparatus I neglected to state the cost of installing the machine. The total cost of the apparatus, including the breeding chamber and installation, is from $1,600 to $1,800. This is not an expensive apparatus when you think of controlling the moisture and temperature in two large chambers each 6 x 8 x 7 feet, or chambers large enough for a man to enter and carry on his experiments. The machine, as the illustrations show, is built for durability and should last for many years.

MR. F. C. BISHOP: I should like to ask Mr. Dean about the degrees of humidity. You say you have it at 6C degrees, but could you maintain it lower?

MR. G. A. DEAN: The most difficult control would be a low humidity with a low temperature. There would be no difficulty in maintaining either a low humidity or a high humidity with a high temperature or a high humidity with a low temperature. If you want a low humidity with a low temperature, one bank of spray nozzles should be turned off so that the relative humidity of the air passing through the spray chamber will be about 60 per cent. The temperature of the air will be within one degree of the temperature of the spray water. When this air is passed to the heating chamber and the temperature raised, the humidity will be lowered. If the temperature and humidity are not low enough the air will have to pass through colder water; for instance, one could use salty ice water. This water

can be used in the spray chamber as well as hydrant water. Bear in mind if you know the absolute humidity and temperature of the air as it leaves the humidifier or spray chamber, the thermostat in the breeding chamber can be set so as to lower the humidity of the air as it passes through the heating chamber. Of course, this increases the temperature of the air.

MR. W. C. O'KANE: I would like to ask Mr. Dean how in summer, when the atmosphere is saturated, he is going to maintain a low humidity in his machine.

MR. G. A. DEAN: Pass the air through cold water which will give it a temperature within one degree of the water and then condition the air in the heating chamber, by setting the thermostat in the breeding chamber so as to heat or expand the air which will reduce the humidity. If hydrant water is used I don't suppose the temperature would be much below 60 degrees. There would be no difficulty whatever in maintaining a low humidity with a high temperature.

MR. W. C. O'KANE: With a low temperature and low humidity.

MR. G. A. DEAN: You cannot get a temperature in summer lower than the water used in the spray chamber. If a temperature lower than the hydrant water is desired you must use ice water or even salty ice water. This will give you a low temperature, say perhaps thirty degrees. Then if this air is heated, say to sixty or seventy degrees in the heating chamber, it will be expanded and, of course, the humidity will be lowered. It should be remembered that the apparatus is so constructed as to use the air from the breeding chamber, which will enter the spray chamber already partly conditioned.

PRESIDENT H. T. FERNALD: We will now listen to a paper by Dr. Howard.

NOTES ON THE PROGRESS OF ECONOMIC ENTOMOLOGY

By L. O. HOWARD

When General W. G. LeDuc took office as United States Commissioner of Agriculture July 1, 1877, just 37 years ago, the annual appropriation to the Department was $174,086.96, and there were 77 employees. The Department was in the main a statistical, correspondence and seed distribution bureau. Virtually no research was being carried on. The entomologist, with one assistant only, was engaged almost entirely in the general museum work of the Department. In the country at large there were no state experiment stations, and but three state entomologists, Riley in Missouri, Thomas in Illinois, and Fitch in New York, the last past his days of work. There were prac-

tically no teachers of entomology. Hagen had a few students at Harvard, but did not touch on the economic aspects of the science; Comstock was just beginning to teach at Cornell; Burrill was giving a few lectures out west, and Fernald was soon to begin at Orono.

When Doctor Houston took office as Secretary of Agriculture July 1, 1913, the annual appropriation to the Department was practically eighteen millions of dollars ($17,986,945) and there were 14,478 employees. The Department had become the greatest research organization in the world. The appropriations for entomology were $742,210. The entomological service had become a large Bureau with about six hundred employees of whom more than two hundred were scientifically trained experts. Every state had its competent agricultural experiment station with a force of entomologists. Practically every state had also its agricultural college with teaching in general and economic entomology. In California there were even County Entomologists, and Boston and Philadelphia had their City Entomologists.

In a way the wonderful general increase in agricultural research and agricultural endeavor had carried economic entomology along with it. The passage of the Hatch act and the consequent founding of the state experiment stations were responsible at once for a great increase in the number of working entomologists, while in immediate succession the introduction of the gipsy moth into New England, the appearance of the San José scale in the east, the march of the cotton boll weevil into the southern states, and the discovery of the carriage of disease to man and animals by insects, have made the importance of entomological work greater and greater. It is no wonder that the country rose to these emergencies; that Congress and the legislatures have given large appropriations, and that by virtue of the successful investigations of our rapidly increasing group of entomological workers, the United States has already gained a commanding position among the nations of the world in this branch of applied science.

It is not generally realized, except among a limited group of teachers, just how this extraordinary advance in a few years has influenced the number of students seeking information on economic entomology at the different institutions, nor just in what way it has influenced the character of the instruction. The present year in six of the leading agricultural colleges where most attention is paid to economic entomology, there are 1531 students in entomology and 51 teachers of entomology. These institutions are the Ohio State University, the University of California, Cornell University, the Massachusetts Agricultural College, the University of Illinois and the University of Nebraska. These six I have chosen because they have the largest number of students in this line, but in every agricultural college in the

country sound teaching is going on. In the south, at Clemson College, S. C., at Auburn, Ala., at Baton Rouge, La., and at College Station, Texas, and elsewhere, there are numbers of students and excellent courses. In the northwest it is the same. At Wisconsin there are 103 students and five teachers. In the small college at Bozeman, Montana, there are 27 students. The men in charge of these different departments are all practical men. Most of them, in fact I think all of them, are primarily economic workers. Many of them have been and are still connected with the state agricultural experiment stations. Some of them have been connected with the force of the Bureau of Entomology of the United States Department of Agriculture. Several of them are still collaborators of the Bureau. It follows that these men know the economic problems which confront us, and that they have a broad knowledge of what is going on, not only in this country but in other countries; and it follows further that the instruction which they give is that best designed to bring practical results. Moreover they are a harmonious and coöperative body of men. They all belong to the Association of Economic Entomologists, which, through its annual meetings and its standing committees is constantly facilitating such coöperation. All of these men are keen to grasp new ideas and are so non-conservative as to methods of teaching that they will at any moment introduce new features and new methods.

In its international aspects, economic entomology is developing with great rapidity and will continue to do so. The Association of Economic Entomologists early elected to its membership practically all of the official entomologists of foreign countries, which brought about a universal exchange of publications and frequent correspondence. This has led to visits to America by many foreign entomologists, and many of our own men have gone abroad, so that personal relationship has brought about friendships and mutual aid. There are constant visits to this country on the part of younger men from other countries, for study in the different lines of economic entomology, and the Imperial Bureau of Entomology of Great Britain has, with Dr. Andrew Carnegie's financial aid, founded a series of scholarships in economic entomology which brings several specially selected young Englishmen to this country each year to study in the Bureau and at the colleges and experiment stations. There are six of them in the United States at the present time. They all want to go back to take part in the war, but their government will not let them do so. All this will bring about in the near future an increase in the solidarity of interests and information and mutual helpfulness which already exists among the economic entomologists of the whole civilized world. Each new idea is and will be almost instantly known to all and speedily tested in

every climate and under all sorts of world conditions. Important parasites found in a remote region will not have to be carried immense distances in the future, but will be relayed from one country to another, a generation or so reared at each stop and then sent on.

The passage of the Federal Horticultural Law in 1912 has brought us into the closest relationship with the plant inspection services of other countries, and last year at a congress in Rome an effort was made to harmonize laws and to bring about comparatively uniform systems by the different countries. This is a movement which will gain force in the future. One of the more trivial and unconsidered aspects of the present war is its effect on inspection services. Of course shipments of plants and plant products from the countries engaged are almost entirely at a standstill, but arrangements have been made by our authorities to accept Holland's certificates for Belgian shipments, and the other day I received a note from the French Ambassador stating that his government had cabled him on behalf of Dr. Paul Marchal to the effect that the French inspection service will be carried on to the best of his ability under the circumstances.

How the entomological problems of the future will be met can only be guessed at, but the work of the past few years has greatly increased our belief in the necessity for the most thorough biological study of every injurious form. So many instances have occurred with species whose life history was apparently well understood and whose behavior was also thought to be known but which have been found under intensive study to possess unexpected points of attack, that the importance of the closest study of every species from every point of view has become very evident. The trend is towards intensive study of every phase of the insect's existence.

Since we have built up in this country in these past twenty or thirty years such a very respectable branch of knowledge which we have termed "economic entomology" or "applied entomology," we are naturally proud of our accomplishment and anxious to see the good work continue in the same general way and *under the same name.* But there is a tendency now to break into the solidarity of our branch of science and to unite us with the plant-disease people under the term "phytopathology" in so far as insects affect plant life, and with the internal parasite people, under the term "parasitology," where insects directly affect man or animals. I think that economic entomologists should resist this tendency. The term "phytopathology," in this significance, apparently originated in Germany. Perhaps for the reason that at the time there were practically no economic entomologists in Germany, there was no protest, but when the European San José scale scare occurred in 1898 and an inspection service was started in that

country to prevent the incoming of this dreaded insect, a plant disease man was put at the head of the service, a curious anomaly which probably might not have occurred elsewhere. It is true that an entomologist was appointed under this person, but the service suffered. The term "phytopathology" should be restricted to plant diseases, and many Germans themselves believe this. A society of economic entomologists, on the plan of our own association, was founded in Germany last year, and, through its efforts and increasing importance, it is likely that the encroaching botanists will be held in check. It is perhaps of sufficient interest to state that the congress which was called at Rome last year to consider inspection services was called a phytopathological congress although it was distinctly understood that the function of the congress was to consider questions relating principally to the prevention of international transportation of injurious insects. The United States sent no delegate to this convention, but did send a letter urging that future congresses of the same nature should be termed congresses of economic entomology and phytopathology.

It is very obvious that plant pathology and economic entomology are unrelated in their basic principles. Their successful study requires from workers absolutely different training and wholly different technique. To combine them into one service would be impracticable, except as units of a large agricultural institution. To combine them under one name as a branch of agricultural science is absurd!

The second term, "parasitology," has perhaps a better justification than the other, but the questions relating to the damage done by insects to man and domestic animals is competently handled by the economic entomologists familiar with the whole range of entomological activity. Why take a protozoölogist or a helminthologist and make him learn all about the insects that affect animals in order to become a parasitologist, when the men who have always worked at economic entomology are handling the same questions under another term? In our entomological proceedings and in our entomological journals and our entomological reports all matters relating to insects are brought together. Why put entomological material together with a lot of plant disease material into a publication entitled phytopathology, and why mix up a lot of entomological material with a lot of other material on worms and the like in a publication called parasitology? And after a branch of applied science has been so well grounded and so successfully carried on under a comprehensive and at the same time exact term like "economic entomology," why try to confuse matters and break into a field so well defined and so successfully organized?

Both terms have come to us from Europe, and the attempt to in-

troduce them into this country has been made by Americans who have studied under European masters. It seems to me, however, that the term "economic entomology," or "applied entomology," is more likely to take a firmer hold in Europe than is the term "phytopathology," in this significance, to gain ground in this country, and that will mean that internationally the term "economic entomology" as applying to the whole field will be generally adopted.

That side of economic entomology which relates to the carriage of disease by insects has been aptly termed "medical entomology," and is best carried on by trained entomologists. The truth of this statement is probably self-evident, but if a convincing argument is needed, it will be found in Hunter's admirable address on medical entomology before the Twenty-fifth Annual Meeting of the Association of Economic Entomologists (JOURNAL OF ECONOMIC ENTOMOLOGY, February, 1913, pages 27 to 38). It is in this field of applied entomology that we must perhaps look for the greatest advances in coming years.

And now at the close of 1914, after considering the results already achieved, and with a knowledge of the investigations under way and of the men who are handling them, with the sound instruction which is being given in two score institutions of learning, with the hundreds upon hundreds of clever students, many of whom will make this field their life work, it is impossible to avoid the conclusion that we are carrying on and will continue to carry on a winning fight against the greatest enemies of the human race.

MR. C. GORDON HEWITT: I would like to express my great appreciation and full concurrence with all that Dr. Howard has said in this most admirable brief résumé of the present position of economic entomology. I want to say for my own part that I am entirely in sympathy with the remarks of Dr. Howard in the latter part of his address where he spoke of merging economic entomology and plant pathology under one head. Dr. Howard has pointed out that the misuse of the term originated in Europe. For many years there were not in Europe economic entomologists of the same training and standard as we have here and often the plant pathologist and economic entomologist were one and the same person and the work was included under the same head, particularly on the European continent. I am very glad, indeed, that Dr. Howard has pointed out the importance of keeping entomological work separate, because I think we ought to take a firm stand at this time when there is still a tendency in certain quarters to include entomology under the term phytopathology. While we all realize that our work is very intimately associated with plant

pathology, just as it is also with bacteriology, it is nevertheless necessary to keep it absolutely distinct.

Before sitting down, I should like to publicly express my hearty thanks to Dr. Howard and to the members of the Bureau and also to entomologists in the United States—for their hearty coöperation with us in our work in Canada. I realize more than anyone else the necessity of our work being international in scope and character. The international boundary is not recognized by our governments in a military manner and as insects do not recognize such political frontiers, we shall succeed best in our efforts by the closest coöperation over the whole range covered by the insects we may be endeavoring to control.

MR. E. P. FELT: It is unnecessary to discuss Dr. Howard's paper, because he has given us a most admirable summary; but I think, speaking for myself and probably for other members of the Association, that we all heartily indorse Dr. Howard's position.

PRESIDENT H. T. FERNALD: I have been very much interested in Dr. Howard's remarks and heartily agree with him on every point which he has made—in fact, the paper was so conclusive that I questioned in my own mind if there would be the possibility of much discussion on lines where we were all certainly so much in hearty agreement with the positions he took.

Report of the Section of Apiary Inspection

The third annual meeting of the Section of Apiary Inspection was held in Philadelphia, Monday evening, December 28, 1914. Inspectors were present from ten different states. Reports of progress being made in apiary inspection work were given by all inspectors present. It was reported that efforts are now being made by several states to have a new apiary inspection law passed. Two states reported failure on the part of their legislators to make appropriation for apiary inspection but stated that the mistake would probably result in larger appropriations at the next session. Reports from other states indicate increasing appropriations for this kind of work.

Dr. E. F. Phillips reported that he had on hand an unexpended balance of $14.25, left from membership dues received from members of the Association of Official Apiary Inspectors of the United States and Canada which was organized December, 1911, at Washington. After this association affiliated with the Association of Economic Entomologists as the Section of Apiary Inspection, it was impossible for eleven of these members to become members of the section because they were not entomologists. Dr. Phillips proposed that membership dues be returned to these eleven men and that the balance of $3.25

be turned over to the Secretary of the Association of Economic Entomologists. The Section expressed its approval of this plan.

Dr. E. F. Phillips, of Washington, D. C., was elected Chairman and N. E. Shaw, Columbus, Secretary, for the coming year. These selections were recommended to the nominating committee of the Association of Economic Entomologists.

N. E. SHAW.

ADDRESS OF THE CHAIRMAN

By WILMON NEWELL, *College Station, Texas*

The Section of Apiary Inspection is a comparatively recent development in the Association of Economic Entomologists. This body was formally organized in Washington, D. C., in December, 1911, under the name of the "Association of Official Apiary Inspectors of the United States and Canada." A year later, at the Cleveland meeting, it affiliated with the Association of Economic Entomologists and received the rank of a section. A short but interesting program of the section was held at the Atlanta meeting a year ago.

The work of the economic entomologist is mainly one of conservation. It is his province to provide methods of protecting crops, fruits, etc., either in the course of their production or after they have been harvested. The conviction that this constituted the sole field of the economic entomologist was so firmly fixed that even the entomologists themselves did not regard the study of wealth-producing insects, such as the honey-bee, as a legitimate part of their work.

However, it must be conceded that the study of beneficial insects of every kind constitutes economic entomological work just as surely as does the study of injurious forms.

It was but appropriate, then, that entomologists, though somewhat tardily, should turn their attention to the development of the beekeeping industry and to the problems connected therewith. Six Experiment Stations, Minnesota, Iowa, Massachusetts, Oklahoma, Texas, and Ontario, Can., now operate experimental apiaries for the development of better methods of beekeeping and the Bureau of Entomology at Washington has done much in recent years to bring the beekeeping industry into the prominence which its importance merits.

The most important phase of this work has been the protection of bees against infectious and contagious diseases and many states now maintain, through their state entomological departments, an efficient apiary inspection system, not unlike the older system of nursery and orchard inspection. In states where this work has been in other hands

there is a growing inclination to transfer it to the entomological departments. This branch of entomological work is each year becoming of more and more importance and it is most appropriate that our program this evening should have as its opening number a report of progress from the various states.

The addition of apicultural inspection to the already heavy load of duties carried by the average economic entomologist has presented many new problems in efficiency. For example, the task of keeping adequate records, often with insufficient clerical help, without seriously hampering other lines of entomological work, is one which has been faced by most of our members. Proper correlation of the field work with that of the office also presents new questions for solution. A knowledge of the distribution of bee diseases, and the means by which they are disseminated, is of the utmost importance to the apiary inspector, for he who knows from whence the enemy is to come is more than half prepared to meet him.

These questions are to be discussed this evening by gentlemen who have not only given them long and careful consideration but who, by experience, have tested their own methods and found them not wanting.

THE DISTRIBUTION OF AMERICAN AND EUROPEAN FOUL BROOD IN THE UNITED STATES

By E. F. Phillips, *Washington, D. C.*

(Withdrawn for publication elsewhere.)

A SIMPLE RECORD SYSTEM FOR APIARY INSPECTION

By W. E. Britton, *New Haven, Conn.*

In Connecticut, the first apiary inspection law was passed by the legislature of 1909, but the measure went into effect so late in the season that no actual inspection work could be done before the summer of 1910. As the law provided that permanent records open to public inspection should be kept on file in the office of the State Entomologist, we were obliged to devise a system to meet the requirements of the situation.

Inspection reports filled out in the field are apt to become soiled and lack uniformity; names and addresses of beekeepers often vary in different reports; the writing is usually done hurriedly so that the reports are hardly suitable for filing as permanent records. After

giving some study to the matter the following system was devised, and has been in use ever since. Though perhaps not perfect, it is both simple and flexible, and has been found satisfactory.

The permanent office records are kept on ruled 5 x 8 inch cards. Each line holds the records of a year, and each card will answer for about fifteen years.

At the top of the card is typewritten the name and address of the beekeeper, care being taken to give accurately the name of the town and the mail address, which are often different near town boundaries and especially on rural free delivery routes.

The card is then cross-ruled and divided into twelve vertical columns with printed headings as follows: Date of Inspecton; Number of Colonies; Diseased with Foul Brood—American, European; Treatment Given; General Condition of Apiary; Date of 2nd Inspection; Condition at Time of 2nd Inspection; Experience in Beekeeping; Quarantine—Placed, Lifted; Name of Inspector.

These permanent records cards are filled out by the clerk in the office from the inspector's reports which are generally sent in once a week or perhaps twice a month. The inspector's report blanks contain: Name of Beekeeper; Town address; P. O. Address; Number of Colonies in Apiary; Number with Foul Brood (American or European); Other Troubles; Owner's Experience; Treatment Given; Date of Inspection; Date Quarantined; Date Released; Certificate Granted; and Name of Inspector. These are made up in booklets each containing 50 solid white pages for the originals, and alternating with them are 50 yellow sheets for the carbon copies. The yellow sheets are perforated and are torn out and sent to the office and the data copied upon the permanent record cards.

The record cards are punched for the round center rod, and are made out in duplicate, one set being arranged by towns and the other alphabetically.

For convenience in readily looking over the work of the season during its progress, each card in the town index on receiving a new record is marked at the top by one of Smith's steel signals. If the apiary was not found diseased a light blue signal is used. If foul brood of either kind is found in an apiary the card is marked with a light red signal. These signals show at a glance, the total number of inspections recorded for the year, the number in each town and the ratio between healthy and diseased apiaries. Before beginning the next season's work or after the year's report has been prepared, these signals are removed. Their legitimate use will often save much time, especially where it is otherwise necessary to examine every card in the index to acquire the needed information.

Some may object to this system on account of the possible danger of error in transcribing the data from the inspector's report to the permanent record cards. I believe that this is not a valid objection. Of course it means more work in the office, but the records are in so much better condition than they could possibly be if made out in the field that I believe that the extra labor is warranted.

Our chief mistakes usually occur in the names and addresses on the inspector's reports and we write to the inspector at once and the correction is made. Thus the copying record system really serves as a check on the reports of the inspector.

INSPECTION AS A UNIT IN THE MASSACHUSETTS APICULTURAL SERVICE

By Burton N. Gates, *Amherst, Mass.*

The apicultural work of Massachusetts, although it is new, is somewhat peculiar in that its several phases are centralized in one office. These are administered, however, under separate appropriations and by separate boards, or directors. The work of the State Board of Agriculture is specified by law as apiary inspection, and under this heading I will explain its several features. The Agricultural College work is divided into several parts. There is the apicultural work for regularly enrolled college students; investigational work for the Experiment Station; and several types of apicultural extension authorized and directed by the Extension Service. Besides these several groups, there is a considerable amount of both state and national associational detail which passes through the office. Schedules and programs for meetings and field days, the preparation of propaganda and news items may be mentioned by way of illustration.

Since the writer is frequently called upon to explain the organization of the beekeeping work as a whole, it may be well to mention first its scope under the heading of the College.

College.—To the regularly enrolled students, there are offered at present two courses. The first, intended primarily for juniors, is a general course, attempting to ground the student in the fundamentals of the subject. The second is primarily a senior course, and is intended to take up more special phases of the subject. It gives also an inkling of some of the larger problems confronting students of beekeeping, which require experimentation and affords some opportunity to acquire familiarity with experimental method.

Museum.—In connection with the teaching, there is maintained a beekeeping museum where already there have accumulated hundreds

and perhaps thousands of specimens, illustrative of natural history, apiarian products and equipment, both foreign and domestic. The purpose of the museum is to afford an opportunity for comparisons, to develop or stimulate improvements, for example adapted to a special purpose. Likewise, it shows up inferiority in mechanisms and devices, brands of supplies and products. Those persons of an inventive temperament are at liberty to compare inventions of the best and benefit accordingly. Perhaps this is more important than the accumulation of natural history material which is the more common purpose of a museum.

LIBRARY.—There is being accumulated also a beekeeping library aside from the author's collection. It is found desirable to gather and preserve the transient periodicals as well as supply-catalogs and lists. Such material is especially valuable to the research student.

THE APIARY.—An apiary on a substantial and practical basis is a new feature in any college. Heretofore, agricultural colleges have shown but a passive interest in maintaining bees. Therefore the development of a demonstrational, yet practical working apiary, has required the working out for the first time, of a great many new features. Some of these as planned, and yet but partially practiced, aside from the keeping of fifty colonies of bees, are the bee garden where it is hoped to demonstrate some of the more important honey plants; and the workshop where hive construction is taught. In teaching the construction and building of hives, while it might not readily be presumed, the fundamentals of hive utilization are also brought forth. There is the honey room with its extraction equipment. Besides this, there will be developed a bottling equipment upon the most approved principles. The wax rendering laboratory is also another feature.

This is partially an item of the Extension Service, yet it is maintained apart from it. Its origin is recent and at first it was designed merely to demonstrate the principles of handling wax. Later it was found that vast quantities of old comb were being burned up by the beekeepers throughout the State. As a unit of the inspection service, it then became desirable to salvage these combs rather than to destroy them. Plans and facilities were prepared so that now beekeepers are at liberty to send their scrap wax and old combs to the College for rendering, at a slight cost. Naturally the more improved equipment of the institution obtains a higher percentage of wax than the beekeeper can get. It saves him then, both wax and labor, and reduces his costs. Already (and the wax rendering service has been in operation but a few months) the value of the wax rendered approaches one thousand dollars. This is an important advance, moreover, in the central-service-station idea.

EXPERIMENT STATION.—The work for the Experiment Station need not be dwelt upon. Naturally it falls into the well-defined policies of such an institution. At present one of the problems concerns beeswax, an effort being made to determine the amount of wax in combs of different types, to the end of improving extraction processes. A number of other experimental problems are also in hand.

EXTENSION SERVICE.—For the extension service, the work may be grouped under short courses, conventions, fairs, itinerant schools and correspondence course. The extension work in beekeeping is so essentially new that efforts thus far are in nature experimental. The value and importance of extension schools is now proven. The itinerant school, however, has not yet been tried. The first will doubtless be held early in the spring of 1915. For several years, however, short courses have been given. These started with a special two-weeks beekeepers' school. This was essentially a cram course, the students' entire time being devoted to the one subject. The work consisted of lectures, demonstrations, laboratory work and excursions. At the end of two weeks, a convention for one or two days at which prominent apiarists and lecturers were in attendance, was held. This kind of a course, however, has its limitations, and in some ways the ten-weeks winter school in beekeeping has proven more desirable. It is given in conjunction with other subjects, as, for instance, poultry keeping, horticulture, or pomology, and is directly correlated with the trend of the student's work. This course is terminated by Farmers' Week, during which there is a Beekeepers' Day. It is one of the convention days in beekeeping for the State.

For the first time, in the fall of 1914, the Extension Service offered a beekeeping exhibit for fairs. A ton or more of material has been cased and prepared for this exhibition purpose; it has been found to meet with decided approval among the people of the State. Besides a static exhibit of hives and implements, natural history specimens and the like, there is a dynamic feature, namely, the display of bees and queens, together with demonstrations of the handling of bees. It is needless to say that such a feature is more or less sensational, yet it has a definite educational value. Aside from the demonstrational work at fairs, there have been held special demonstrations to meet local conditions, which might be termed emergency field days or conventions. This phase of apicultural extension is of decided worth and is capable of considerable expansion. It takes the College directly to the beekeeper.

THE STATE BOARD OF AGRICULTURE: APIARY INSPECTION.—Apiary inspection is by no means the least important of the State's duties to the beekeepers. As might be inferred in Massachusetts, it forms an

integral part of the whole. The inspection work, however, is not disassociated from the work at the College any more than the converse is true. The work of the state being a unit requires that all its features be interlocking; the College helps the inspection work and the inspection is essential to the college.

At present the law allows but four inspectors, three of whom are deputies, with an appropriation of $2,000 per annum. This is decidedly inadequate to satisfactorily meet the demands.

INSPECTION POLICY.—Massachusetts, like most New England states, is exceedingly conservative. The beekeepers are zealous in demanding attention; therefore they cannot be skipped. It has been found that to go into any one locality and visit only a few of the beekeepers there, brings down a rain of complaints from the other beekeepers. Consequently the policy of inspection in Massachusetts is slightly different from that in some states, where it has been advocated that only such apiaries be visited as are known to be diseased or of enough commercial importance to warrant inspection. Directly opposed to this policy, Massachusetts inspection has been an apiary to apiary canvass, starting with a center or focus of infection. Gradually the inspector enlarges his territory from this central point by concentric circles, until the limit of infection is found. A map of the inspection work would show that relatively well-defined areas of infection occur. Of course there are some few scattering cases, which are gradually checked up. That this method applies in Massachusetts has been proven from the demands of the beekeepers and from the decrease of infection in given localities. I take, for illustration, the county of Berkshire, where beekeeping prospers particularly, and where, being against New York State, infection with European foul brood in 1910 and 1911 was very general. The beekeepers, too, were discouraged. They thought disease had come to stay. Now the disease is on the wane and beekeeping is on the climb. Apiaries are being enlarged. Moreover, beekeepers are of a better and more earnest type, as might be expected. The shiftless, let-alone beekeeper has had to go. A few more years doubtless will show greater improvement; but, the present status may be learned from the table below.

COMPARATIVE TABLE, SHOWING THE BEE-DISEASE STATUS OF BERKSHIRE COUNTY, MASS., IN 1914

Apiaries		*Colonies*	
Visited	Infected	Examined	Infected*
1911 154	70 or 45%	980	439 or 43%
1914 179	25 or 14%	1028	72 or 7%

*Entirely European foul brood in this County.

From this table it will be seen that of the apiaries visited in 1911 and 1914, the percentage of infected apiaries has dropped from 45 per cent to 14 per cent. Likewise, from the standpoint of the individual colonies, the percentage of infected colonies has dropped from 43 per cent to 7 per cent. This has a further significance in that there is an increase in the number of colonies which, though slight, must be interpreted with reference to the elimination of the smaller and less prosperous beekeepers. Some of the largest apiaries in the county showed in 1914 no disease whatever, although these yards were in sad condition previously.

Similar indications of improvement, even to the extent of exceeding the most optimistic anticipations of the beekeepers and inspectors, might be cited for other parts of the State. It should be acknowledged, however, that there are still some rather seriously infected localities, which it has been possible to reach only after the elimination of infection in territories already under subjection.

The writer is frequently asked to mention the more important features which have tended toward efficiency in Massachusetts inspection. They may be listed.

Records.—The record cards are individual for each apiary and beekeeper in the state. Being of the loose-leaf principle allows them to be kept as a vertical file. The record cards are issued directly to the inspectors when routing their territory. Thus the inspector has before him the complete history of each yard or apiarist and of every transaction concerning both, even to knowing whether he has bought or sold bees within or without the State. Complete records have repeatedly proven of inestimable service. In the long run they will also afford a comparative statistical study of the State. The inspectors are required to fill in data concerning spring count, winter loss, number of colonies examined, diseased, etc. It takes but little time to record such, but it is required that the entries be made *on the premises at the time of inspection*, and not later transcribed from a notebook. As soon as the inspection of a town is completed the records are returned to the office, where they are kept on file. Information gained by inspectors is held as confidential.

Report Card.—The inspectors have found a report card, which they term the "clean up" order, of considerable advantage. This is a printed form which when signed, causes the beekeeper to promise that he will obey the instructions of the inspector, either to clean up an unsanitary apiary, or to treat or destroy infected colonies, before a given date. It further provides that the beekeeper shall notify the office of having fulfilled these instructions. Space is afforded for the beekeeper to indicate his desire for publications which will be sent from

the office, upon receipt of his request. The detached portion of the "clean up" order, which is left with the beekeeper, he should mail to the office upon completion of his work. It bears a few practical suggestions concerning disease.

INTERSTATE SHIPMENTS.—One of the particularly advantageous features is the control of interstate shipments. The legal provisions are that no colonies upon combs may be shipped into the state from a state where there is an inspector unless their healthfulness is certified by a state apiary inspector. This limits an objectionable policy, which has been termed the "dumping" of disease into Massachusetts. From states where there are no apiary inspectors, stock is received without certificate, but the recipient is expected to notify the inspector of apiaries of its arrival, thus enabling a subsequent inspection of the stock. Only one addition would be recommended, namely that transportation companies be obliged to notify the inspector of the arrival of all stock from without the State. It has been said that in so legislating, Massachusetts has placed an embargo upon bees, but this cannot justly be maintained because legitimate shipments are provided for. In watching the practicability of this feature of the law, it has been noticed that beekeepers have been less imposed upon than perhaps they would have been otherwise. No complaint, but rather approval is made by the beekeepers of the state. There is less likelihood, moreover, that the conscientious work of inspectors may be upset through some careless shipment of diseased stock.

QUARANTINE SYSTEM.—Formerly it was not customary for states to quarantine apiaries found to be infected. This is now more general and need not be dwelt upon, except to say that it is an indispensable feature of an inspection law. It protects not only the inspector, who, by an unscrupulous beekeeper might be misled or deceived, but it also protects the well-meaning beekeeper and limits the person of ill-intent. It also holds infectious materials on the premises where found until they have been properly and satisfactorily disposed of. Moreover, it is not without its moral advantage in stimulating beekeepers to watch out for the occurrence of disease, which, when they are conversant, they may treat before the inspector arrives, thereby obviating quarantine. Morally, too, it stimulates prompt treatment of a quarantined apiary.

FORMS.—Summarily, there are five forms used by the inspectors (the record card, which is good for a period of eight or ten years; the quarantine blank and the release blank; the "clean up" report used in unsanitary apiaries; and the report used in apiaries in which there is found infection). The writer will gladly send specimens of these forms to inquirers.

Proceedings of the Thirteenth Annual Meeting of the American Association of Official Horticultural Inspectors

The Thirteenth Annual Meeting of the American Association of Official Horticultural Inspectors was held in Philadelphia, Pa., December 29 and 30, 1914.

The first session was held in the parlors of the Hotel Walton, and was called to order at 8.00 p. m. by the Chairman, W. E. Britton, with J. G. Sanders, Secretary.

The second session was called to order at 10.00 a. m. Wednesday, December 30, in the Veterinary Building of the University of Pennsylvania.

Upwards of 75 inspectors and visitors were present at each session, including several members of the legislative committee of the American Association of Nurserymen who were invited to attend the meetings of the inspectors for our mutual benefit.

The following program was presented at the two sessions of the meetings:

PROGRAM

Tuesday, December 29, 1914—8.00 p. m.

1. Address of the Chairman, W. E. Britton, New Haven, Conn.
2. Important Insect Pests Collected on Imported Nursery Stock in 1914. *15 min.* E. R. Sasscer, Federal Horticultural Board, Washington, D. C.
3. Some Recent Insect Importations into New Jersey. *10 min.* H. B. Weiss, New Brunswick, N. J.

Informal Discussion of Question 1

Wednesday, December 30, 1914—10.00 a. m.

4. Prevention of Rabbit Injury to Young Apple Trees. *5 min.* E. N. Cory, College Park, Md.
5. The Training of a Nursery Inspector. *15 min.* R. Kent Beattie, Federal Horticultural Board, Washington, D. C.
6. The Missouri Inspection Service. *10 min.* L. Haseman, Columbia, Mo.
7. Essentials in Insect Control. (A Plea for Greater Simplicity.) *10 min.* T. J. Headlee, New Brunswick, N. J.

Informal Discussion of Questions 2, 3, 4, and 5

Election of Officers for 1915—Business.

8. A Model Nursery and Orchard Inspection Law. (Progress Report.) *15 min.* J. G. Sanders, Madison, Wis.

General Discussion led by Mr. Wm. Pitkin, Rochester, N. Y., Chairman of Committee on Legislation of the American Association of Nurserymen.

QUESTIONS

1. Should further importation of all nursery stock be prohibited by Federal law, except in very limited amount for experimental propagation by the United States Department of Agriculture?
2. What is the proper treatment for scale-infested premises in close proximity to nurseries?
3. Should we require fumigation of all susceptible nursery stock grown in states known to be generally infested with San José Scale?
4. By what means can the standard of efficiency of inspectors be raised?
5. Should horticultural inspectors furnish a bond?

SUMMARY OF PAPERS AND DISCUSSIONS

1. Address of the Chairman. Dr. Britton reviewed concisely the early work of inspection of nursery stock and the reasons therefor, outlining the method of introduction of the San José scale into the United States and more particularly into eastern United States. He recounted the various successive steps taken by state authorities to safeguard the growing and distribution of nursery stock. The quarantine and inspection of imported plant material was also discussed and reference was made to the necessity of greater uniformity in the inspection laws of the various states.

2. The paper on "Important Insect Pests Collected on Imported Nursery Stock in 1914" by Mr. E. R. Sasscer of the Federal Horticultural Board, Washington, D. C., provoked considerable discussion on the part of the inspectors present. It was urged by the members of the Federal Board present that all species of insects and fungous diseases found on imported plant material, even though they be common ones, be reported to the Federal Board since full reports are valuable in showing laxity of inspection, and ultimately formed a general argument against free and promiscuous importation of plant material.

Mr. Rogers asked for a bullet n describing the important pests likely to be found on imported plants, believing that such a handbook should be available to all inspectors whose duty it was to inspect imported material.

Mr. Marlatt reported progress on such a bulletin to be published by the department of agriculture, which probably would appear in the form of a handbook. Over 100 illustrations and much manuscript is already submitted and may be published within the next year. This publication will also include a treatise on the fungus and bacterial diseases concerned with imported plants, the manuscript for which is n course of preparation by Dr. Perley Spaulding.

Dr. Britton asked for information concerning the recently imported

"pine bud moth" to which Mr. Marlatt replied that a preliminary paper by Dr. A. D. Hopkins is available. Also that Mr. August Busck of the U. S. National Museum is preparing a bulletin on this new pest. Mr. Marlatt further stated that the imported species differs from the native spruce bud moth in that it works deeper into the twig, causing greater damage and the recovery of twigs is rare. It is already known from twelve different states although so far it is largely a nursery problem.

Mr. Sasscer reported that there is in course of preparation a list of imported pests, arranged according to host, which list will soon be issued as a letter of information.

Mr. Schoene stated briefly that there seemed little actual necessity for promiscuous importation from Europe of our own native species of plants or of species easily grown here.

3. In the paper on "Some Recent Insect Importations into New Jersey," H. B. Weiss, New Brunswick, among other pests, reported the finding of Argentine ants in a shipment from Germany in greenhouse plants, the certain identification of which was made by Dr. W. M. Wheeler. It is also reported that 198 egg masses of Gipsy Moth had been found at Rutherford, N. J., where the infestation has continued for two years or more. Immediate and drastic measures were carried out and it is believed that New Jersey is now freed from this pest.

Question 1 of the program was discussed at length during the remainder of the session. This discussion brought forth opinions from the various Federal and State Inspectors present, as well as from the nursery men who were in attendance at the meeting. Summarizing the discussion, it was the general opinion of the majority present that certain prohibitions on the promiscuous importation of plants could be made without seriously hampering the nursery trade, particularly if a certain date was set a year or two in advance after which the importation of certain plant material should be curtailed. There was further discussion relating to the possibility of propagating seedling stock in America advantageously and thus eliminate the possibility of introducing more pests on this class of importation. Opinions on this question were at considerable variance but there seemed to be a general feeling that our native conifers should be propagated in this country and that further importations of conifers could be prohibited without serious handicap.

In the Wednesday forenoon session the paper on the training of a nursery inspector, by R. Kent Beattie of the Federal Horticultural Board, brought forth considerable discussion regarding the training of the inspector and the value of inspection. Dr. Fernald stated that,

in his opinion, the value of an inspection depends absolutely on the training, care and experience of the inspector, and that on these personal factors hinge the entire value of inspection and the certificate which is granted. Dr. Fernald also reported the examination of 100 records of "blister rust" and that in no case had one been found on gooseberry, but that all of them were shown to be infections on currant.

Discussion of question 2, at this point, showed a general agreement that the inspector should have authority to inspect and clean up scale infested premises in close proximity to nurseries.

There was considerable variation in opinions regarding the fumigation of susceptible nursery stock which was grown in regions known to be generally infested with San José scale; and the complaint was made that many horticulturists strenuously objected to the planting of fumigated trees.

Question 4 brought forth the general feeling that the statement previously made by Dr. Fernald, appearing above, was the only practical solution of the efficiency of inspectors.

Question 5 relating to the bonding of inspectors provoked a short discussion which brought forth the general opinion that in case the chief inspector was required to furnish a thousand dollar bond, greater care and consideration of the stock and its condition and treatment would be observed; and further, that in case stock was illegally or unnecessarily destroyed, nurserymen might have some redress through proper court proceedings.

BUSINESS

Professor Symons moved that there should not be held a special summer meeting of the Horticultural Inspectors at the time of the summer meetings to be held in California, and that any papers relating to horticultural inspection be offered at the meeting of the Economic Entomologists. Carried.

The nominating committee nominated Prof. W. E. Rumsey of Morgantown, W. Va., for chairman of the next annual meeting and Prof. J. G. Sanders, Madison, Wisconsin, as secretary. These officers were unanimously elected.

The model nursery and inspection law, which was drawn up in November 1913 and was considered at the Atlanta meeting and reported back for further consideration, was considered and debated. Copies of this law, in its latest form, were available at the meeting but the copies presented did not contain the latest alterations made during the conference held the previous day with the legislative committee of the Association of Nurserymen.

After considerable discussion, it was moved by Prof. Symons that

"the Association approve the substance of the proposed bill and that a committee be appointed by the chair to consist of five members to approve the final wording of the bill. Said committee to have power to act." The committee appointed by the chair consisted of Messrs. Marlatt, O'Kane, Worsham, Gillette and Sanders.

SOME RECENT INSECT IMPORTATIONS INTO NEW JERSEY

By HARRY B. WEISS, *New Brunswick, N. J.*

Inasmuch as the state of New Jersey imports from the various countries of Europe, Asia and South America, an average of 12,000 parcels of nursery stock every year, it is not surprising to find injurious forms coming over and in some instances becoming established. Scale insects are the most numerous of these importations, chief among which are *Coccus hesperidum* Linn. occurring on bay trees from Belgium, *Chrysomphalus dictyospermi* Morg. on palms from Belgium, *Hemichionaspis aspidistræ* Sign. on aspidistra and ferns from Belgium, *Diaspis boisduvalli* on orchids from England, *Targionia biformis* Ckll. on orchids from Venezuela and the United States of Colombia, *Pseudaonidia pæoniæ* Ckll. on azaleas from Japan and *Diaspis pentagona* Targ. on peach stock from Japan, also *Lepidosaphes ulmi* Linn. on boxwood from Holland.

Except in the case of greenhouse species which were established in New Jersey, all infested plants were destroyed. During the fall of 1911 ants were taken from the packing in a case of roses imported from Germany. Unfortunately they were overlooked until the spring of 1914 when they were sent to Dr. W. M. Wheeler who identified them as specimens of the Argentine ant, *Iridomyrmex humilis* Mayr, which has been such a plague in the southern states and in California and which has recently been introduced into South Africa and Portugal. Dr. Wheeler was at a loss to understand its occurrence in Germany unless it had happened to be living in greenhouses. It is a tropical species and of course unable to maintain itself out of doors in the northern states or in Germany. Systematic collections of ants were made in several of the largest greenhouses in the state especially where imported stock had been received in large quantities but no Argentine ants were discovered.

Another interesting capture was the taking of *Eucactophagus graphipterus* Champion during April 1914 in an orchid house at Summit, N. J. This large member of the family Calandridæ is a native of Costa Rica and the United States of Colombia. Mr. Schwarz who determined it said that only three specimens were known, one of which had been taken in a Connecticut greenhouse by Dr. Britton.

Ulex europea from England was found infested by *Apion ulicis*, a weevil injurious to the seeds. Members of this genus are found on other leguminous plants and it is one which should be guarded against.

A much more injurious imported beetle in the shape of *Myelophilus piniperda* Linn.[1] was noted by Dr. T. J. Headlee to have gained a slight foothold in a northern New Jersey nursery where it was found attacking Scotch Fir to the extent of boring out the tips of the central shoots. According to Ratzeburg, this beetle does two important kinds of injury. First it attacks for the purpose of breeding, already injured Scotch Fir and quickly brings about its death. Second, it bores out the terminal twigs of young coppice growth causing the tree to assume a crooked unsightly branching habit. The result of this second type of damage is much like that of the white pine weevil. According to Dr. Hopkins, it often does extensive damage to pine trees in Europe and for this reason the section in which it was discovered is being closely watched.

Another imported beetle, *Agrilus viridis* Linn. var. *fagi* Ratz.[2] was found during the past year extensively injuring roses, chiefly in nurseries, in four different places in northern New Jersey. The injurious work of the larva consists of a spiral band of channels in the sap wood over which forms a swelling or gall, above which of course the plant dies. It was found attacking standard roses and *Rosa rugosa* more than other varieties and infested blocks presented the appearance of having been burned over as early as the middle of August. Considering the nature of the injury, cutting and burning of the infested stems during the fall or winter seems to be the best method of control.

Still another unwelcome importation, not from Europe however, but from Florida was *Callopistria floridensis* Guen. known as the Florida Fern Caterpillar. This pest was found during September 1914 injuring ferns in greenhouses at opposite ends of the state and one of the firms in question undoubtedly purchased it in some stage other than the adult along with a shipment of ferns from Florida. It does considerable damage to various species of ferns and in this state has yielded successfully only to handpicking supplemented by trapping the moths. Considering the fact that it is such a troublesome species, it would pay ferngrowers to be on the watch for it when receiving ferns from other establishments.

The most serious finding of the year was made in November, by Government scouts, who discovered 198 egg masses of the gipsy moth, *Porthetria dispar* Linn., at Rutherford. The capture of a perfect male moth on August 1 by a local collector led to these men being placed in the field by Mr. Burgess. The infestation occurred in a small block of nursery evergreens used mostly for show purposes and was at least

[1] Determined by Dr. A. D. Hopkins.

[2] Determined by Mr. Chas. Kerrimans of Belgium.

two years old. It is supposed that the egg masses were brought in on New England stock although no definite proof of this is obtainable.

Unfortunately the funds at our disposal for inspection service are expended almost entirely in the inspection of nurseries and foreign stock, leaving practically nothing for the inspection of domestic stock. It is needless to state that prompt measures were taken with the infested area and the careful scouting of the surrounding area by the Government men led us to believe that New Jersey is still free from this pest.

In addition to injurious species, one will at times find beneficial forms being imported. However as a rule, these are few and far between. Egg masses of the praying mantis are not infrequently brought in on stock from Japan. During the past season, a large black carabid beetle was taken from a case of Japanese azaleas and Mr. Schwarz identified it as *Damaster blaptoides* Kollar. This is a rather rare species, the genus being peculiar to Japan. Its introduction into the United States would of course be highly desirable. *Pterostichus* (*Feronia*) *vulgaris* Linn.[1] another beneficial carabid beetle, very common in central Europe was taken on Holland stock and *Amara ovata* Fabr.[1] from packing around English stock. *Philonthus politus* Fabr.[1] of the family Staphylinidæ was also taken from English stock. The species of this genus live under dung or decaying vegetable matter, the larvæ being predaceous on soft insect larvæ, mostly Dipterous. This of course places it among the beneficial forms.

Various other species mostly injurious but as a rule of lesser importance are taken from imported stock every year. This includes white flies on azaleas from Belgium, ants from Holland and France, *Pseudococcus sp.* on palms and bay trees from Belgium, *Tingitid* eggs on rhododendrons from Holland and *Notolophus antiqua* egg masses also on Holland stock.

One fact stands out plain. In spite of elaborate inspection systems and careful, conscientious work, some injurious foreign species continue to creep in and become established.

CAGES AND METHODS OF STUDYING UNDERGROUND INSECTS[2]

By JOHN J. DAVIS, *Lafayette, Indiana*

Our studies the past few years with *Lachnosterna* and related insects, whose immature stages are passed underground and which have a one- to four-year life-cycle, have given us an opportunity to determine the relative value of various cages.

[1] Determined by Mr. Schwarz.

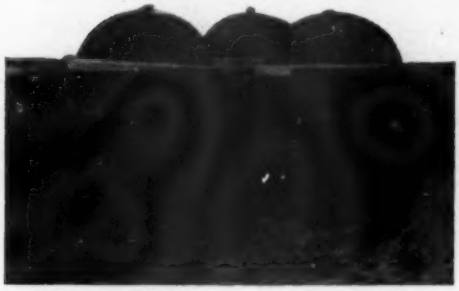
[2] Published by permission of the Chief of the Bureau of Entomology, United States Department of Agriculture.

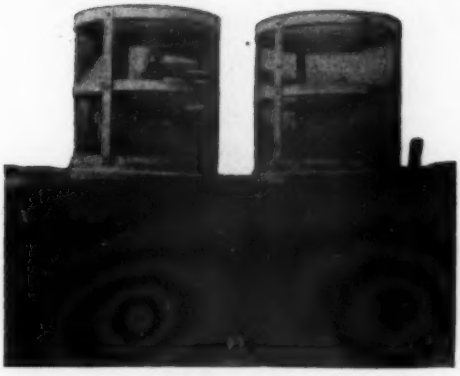
In working out the complete life cycles the following general types of cages have been thoroughly tested with more or less satisfaction. 1. Ordinary standard size flower pots, 12, 15, and 16 inches respectively in diameter and depth. Red pots have proven more satisfactory than others for they do not crack and scale so badly from freezing and thawing (Plate 3, figs. 2 and 4). 2. Cylinder-shaped cages 20 inches in diameter and 4 feet deep, constructed of 18- and 20-mesh brass and bronze wire cloth, buried their entire depth and covered with a cone-shaped wire top. 3. Cylinder-shaped cans, 20 inches in diameter and 2½ feet deep, made of galvanized iron with openings at the bottom for drainage. 4. Cylinder-shaped cans as No. 3 but with 4 square feet of 18- or 20-mesh brass or bronze cloth on sides, and the bottom of the same material. 5. Cylinder-shaped cages entirely of 18-mesh galvanized wire cloth (Gilbert and Bennett's "Pearl" wire) 20 inches in diameter and 2½ feet deep, buried their entire depth, as the others, and covered with cone-shaped wire covers (Pl. 3, fig. 1). 6. Cylinder-shaped cages as No. 5 with an outer casing of heavy 6-mesh galvanized screen. (Pl. 3, fig. 3.) 7. Cages constructed of 20-inch tile, one and two tile deep and covered at the bottom with a durable wire screen. 8. Rectangular-shaped cages 5 x 8 feet in width and length, 2½ feet deep below ground and 2½ feet above ground, constructed of metal and wooden frames covered with 18-mesh pearl wire cloth (Pl. 4, fig. 5).[1]

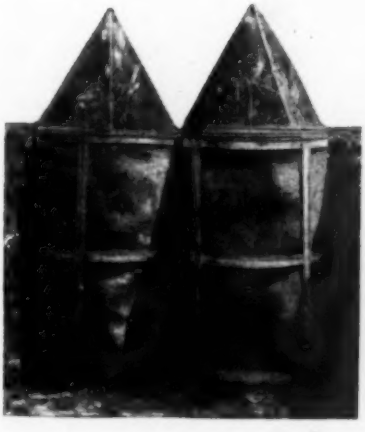
Coleopterous larvæ with a three-year life-cycle were bred in all of the cages from egg to adult. Type No. 2 has been discarded since the galvanized wire will last sufficiently long and is not nearly so expensive as the brass or bronze cloth, and it has been definitely decided that cages need not be over 2½ feet deep, at the most. The tile cages (No. 7) were no more satisfactory than the flower pots and were quite difficult to examine. Cages 5 and 6 were quite satisfactory but they were no more so than the flower pot cages and since they are considerably more expensive, they will hereafter be replaced largely by the latter. Cages 3 and 4 are somewhat cheaper than 5 and 6 and about as satisfactory but will be replaced hereafter by pot cages, for the reason just given. The large rectangular cages (No. 8) are quite satisfactory and are used to serve as checks on the smaller cages. Usually several species of the same genus are placed in each of these.

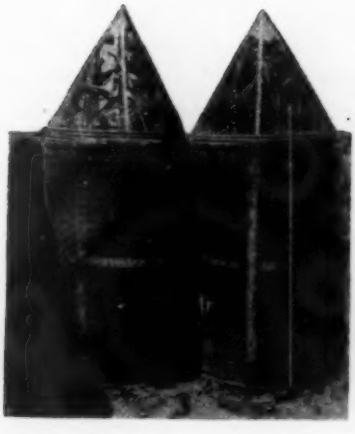
As already intimated, the flower pot cages, taking everything into consideration, are the most satisfactory, are easily handled, cheap, and well suited for underground insects. The pots are filled with good soil

[1] Cages of this style may be used for a double purpose, first as breeding cages for underground insects, and second for studying the seasonal life-history of aerial insects, such as the army worm (*Heliophila unipuncta*) as was done at Lafayette the past year.









BREEDING CAGES

which has been sifted to make certain it is free from insects, and seeded with a mixture of timothy and blue grass. Pieces of old corn stalks are usually included since the *young* grubs (*Lachnosterna*, *Cyclocephala*, *Anomola*, etc.) like to feed on decaying vegetation, and for grubs which are partially or wholly scavengers manure is added. Pots thus prepared are buried in the soil almost to their tops, and covered with cylinder-shaped tops as in the accompanying illustration (Pl. 3, fig. 4). Beetles, preferably pairs collected *in copula* are introduced and in the case of leaf-eating beetles, foliage is supplied as needed. It is necessary at various times to reseed or plant corn in the cages and, above all, it is essential to watch them and water as required, for they do not hold the moisture as does soil under natural conditions. It is equally necessary to water the wire cloth cylinder cages during the warmer and drier parts of the year for they do not retain the moisture any better, if as well, as the pots. During the winter, covers are removed and the pots covered with straw and this with strawy manure to a depth of one foot, which will gradually pack down to a comparatively thin layer (Pl. 5, fig. 9). Since the grubs do not, in flower pot cages, have an opportunity to go down to their normal depth for hibernation, this precaution is desirable and does not materially affect the conditions as found in nature. Cages such as these, which are used to obtain the total life-cycle, are examined for grubs only once or twice in a year in order to obtain specimens of the different aged grubs, and duplicate cages are invariably left undisturbed until the summer the beetles are to appear.

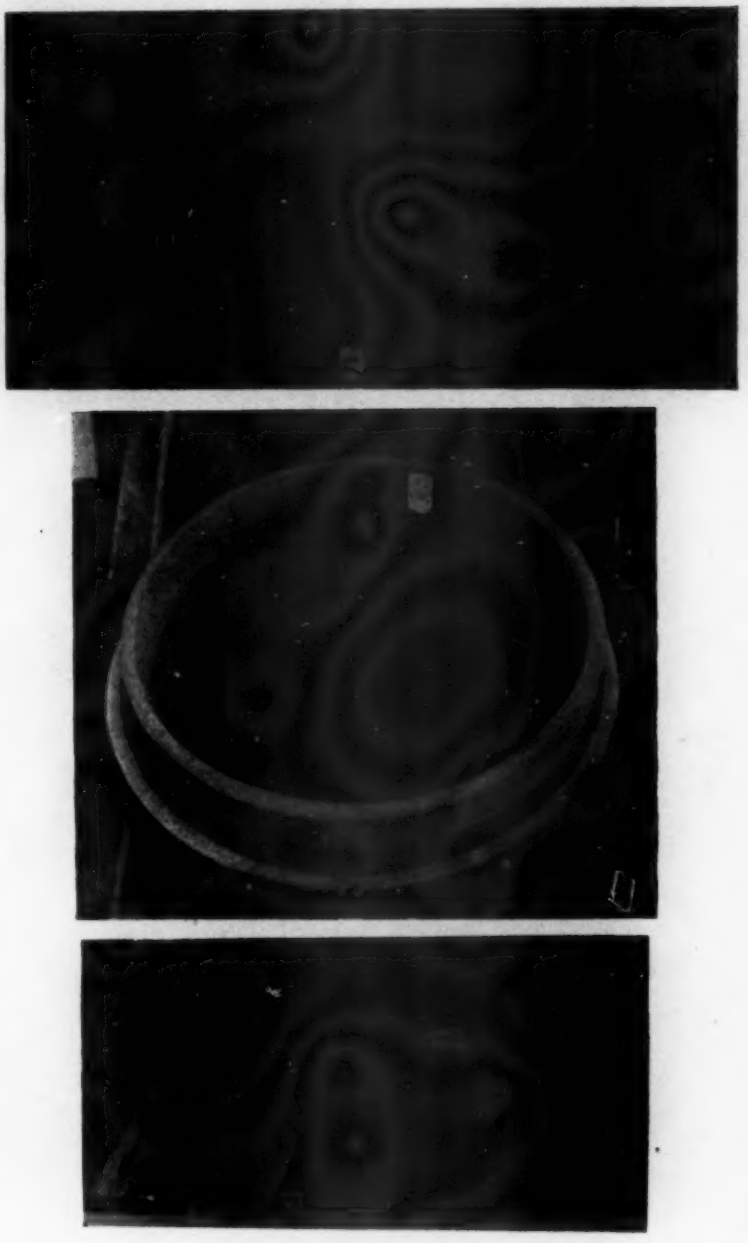
For obtaining eggs and records of individual pairs, 12-inch three-quarter or standard size pots filled with finely sifted soil are used. They are covered with wire screen tops within which single pairs are placed. The soil in these cages is not seeded nor are the pots sunk in the soil, but foliage is supplied as needed and a record kept of the amount of each kind of foliage eaten by the beetles. The pots are kept in a shaded or partially shaded location and every day or every few days the cages are sifted, using a 16-mesh riddle. If the soil contains the proper moisture content, the small balls of earth containing the eggs will remain intact, the loose soil sifting through.[1] The balls of earth are broken in half and the part containing the egg or eggs placed in boxes of soil, or small cavities, resembling the original egg cavity, are made in the boxes of earth and the egg placed therein, a damp camel's hair brush being used to dampen the eggs. The earth in the egg boxes is moistened as necessary and kept in a cool place comparable with natural soil conditions. We have also used shallow

[1] This is the case with *Lachnosterna*, *Allorhina*, *Euphoria*, *Diplotaxis*, etc., but a few beetles do not make such a compact ball and the eggs appear in the riddle free.

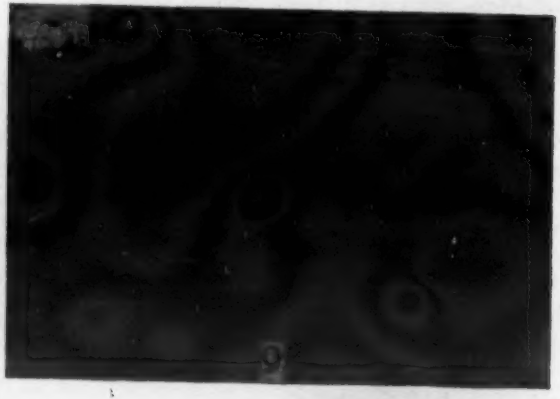
pots known to dealers as fern pots (Pl. 4, fig. 6), for egg incubators but the tin boxes (Pl. 4, fig. 7), have given us more uniform satisfaction.

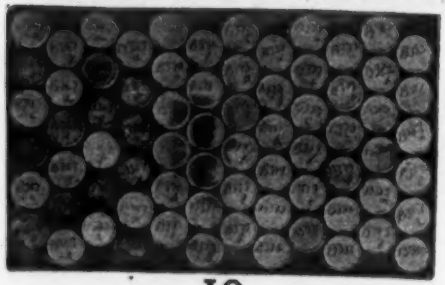
In order to study the habits of the grubs, their growth, molts, etc. one-ounce tin salve boxes are employed (Pl. 5, fig. 12). These are filled with soil, moistened to the proper degree, the grubs placed therein and a grain or two of wheat added. Extreme care is necessary in handling the young grubs and they must be disturbed as little as possible. Older grubs are fed grains of corn and are examined once a week, fresh soil and corn being added as needed. For convenience in handling we have trays (Pl. 5, figs. 10 and 11), made to hold 60 or 70 tin boxes and just the depth of the boxes and these are fitted in grooves, like the drawers of an insect cabinet, thus putting them in compact form and in such shape that any individual drawer or tin tray can be drawn out and examined without disturbing the others. By use of a blue pencil, such as is designed for writing on china, tin, etc., the cage number can be placed directly on the box and it will not be erased except by vigorous rubbing. As winter approaches all of the tin boxes are carefully examined to prepare the grubs for hibernation. All grain and vegetation is removed and the soil properly moistened. Watering, especially at this time of year, is an important item, time and experience alone enabling one to judge; it suffices to say that overwatering is the more natural and consequently to be guarded against. After the boxes are prepared for winter they are left in the tin trays which are placed one on top of the other, or are placed in pasteboard boxes holding a half gross or more, and buried in a compost heap to the depth of from one to two feet (Pl. 5, fig. 8).

The tin boxes above described are invaluable for many purposes. Grubs received from different localities and situations are reared in them with very little effort. When filled with sphagnum moss they make excellent receptacles for sending living grubs and other insects liable to injury in shipment. The past summer we successfully employed them for obtaining molts, length of instars, amounts of foliage eaten during different instars, etc., of the army worm (*Heliophila unipuncta*), one-ounce size being used up to the fifth molt, after which three-ounce boxes were used. They are simple, cheap, easily handled, and the molts readily determined, enabling us to run an extensive series of individuals. It is scarcely necessary to say that in the case of the army worm, check experiments were run to determine whether or not the tin boxes produced unnatural conditions for the larvæ, and in this case they did not, larvæ in the tins behaving, feeding and molting as did larvæ in several other kinds of cages. From our experience with tin boxes they are the simplest breeding cages available and, considering everything, will prove to be as invaluable to the entomologist as to the salve doctor.



BREEDING APPARATUS





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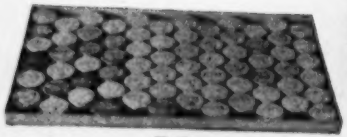

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BREEDING APPARATUS

Since this paper was written Mr. A. A. Girault has published an article on methods of rearing Scarabæid larvæ (JOUR. ECON. ENT., Vol. 7, Dec. 1914, pp. 445–447). The author concludes that the underground Tower cages, which in this case are presumably underground cylinder cages made of wire gauze, are the most satisfactory, wooden boxes next and the flower pots third choice. Other circumstances not referred to in the table must have influenced these conclusions since they are not satisfactorily corroborated therein. Girault does not indicate the size of pots or Tower cages used and this might have a decided influence on the percentage of maturities, nor does he indicate the number of grubs per cage except in the case of a few examples and it is evident that up to a certain limit, the fewer the grubs the greater the percentage of maturities, other factors being equal. Furthermore, only larvæ within five months of pupation were used and in the case of the flower pots all were kept indoors (apparently not buried), hence it is impossible to make a satisfactory comparison between the results secured by Girault and those of the writer. In the case of half-grown grubs it is quite certain from our own results that the small individual tin boxes will prove as satisfactory, if not more so, than pots or other cages. Girault makes an excellent point and one which we corroborate when he says, "It would seem that the kind of cage mattered very little, providing they received good attention."

EXPLANATION OF PLATES 3–5

Plate 3, fig. 1. Large underground breeding cage of 20-mesh Pearl wire cloth.

Fig. 2. 15-inch pots with wire screen dish cover tops.

Fig. 3. Large underground breeding cage of 20-mesh Pearl wire cloth covered with 6-mesh wire screen.

Fig. 4. 15-inch flower pot cage with cylinder-shaped tops.

Plate 4, fig. 5. 5 × 8 ft. underground breeding cage.

Fig. 6. Flower pot saucer egg cage.

Fig. 7. Tin box egg cage.

Plate 5, fig. 8. Compost heap in which certain cages are buried during the winter.

Fig. 9. Row of flower pot underground cages covered with strawy manure.

Figs. 10 and 11. Tray containing individual tin box cages.

Fig. 12. Individual tin boxes showing white grub in prepupal stage and cell constructed by it (natural size).

A PRELIMINARY LIST OF INSECTS WHICH HAVE WILT, WITH A COMPARATIVE STUDY OF THEIR POLYHEDRA[1]

By J. W. Chapman and R. W. Glaser

I. Description of Wilt

Although the nature of wilt in the gipsy moth will be thoroughly discussed by Glaser in a paper soon to be published, a restatement of its recognizable characteristics is necessary for a complete understanding of the discussion which is to follow; also because many persons are of the belief that wilt is peculiar to gipsy moth caterpillars only.

Clinical Picture

The wilt is characterized by the formation in the bodies of infected caterpillars of polyhedral-shaped, highly refractive, angular bodies, which have their origin in the nuclei of the tracheal matrix, hypodermal cells, fat cells and blood corpuscles. Later some of these burst and the poyhedra are set free in the blood. When death results they make up a great part of the saponified body tissues of the caterpillars. The caterpillars hang by their prolegs, become flaccid and their skin disrupts at the slightest touch. An examination immediately after death reveals few or no bacteria and no bad odor. The wilt appears in nature in both a chronic and an acute form. If, however, a dead caterpillar, on microscopic examination, shows no polyhedra it does not have wilt, even though all the gross symptoms may be present.

The point we wish to emphasize is that a consideration of both the external characteristics and the polyhedra is essential to a complete diagnosis of isolated or chronic cases of wilt; because there are a number of diseases of caterpillars, such as fungous, protozoan and possibly bacterial diseases, with which it might easily be confused under such conditions, even by the most experienced. If on the other hand the wilt has reached the epidemic form, it is highly improbable that it could be confused with anything else.

Following this rule of diagnosis we should look for wilt in all forms of insect life; for where it was thought to be rare it has proven to be common and widely distributed as will be seen from the following insects reported to be affected by it. For convenience of discussion and to prevent possible confusion we have divided them into three groups.

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[1] Contribution from the Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution No. 85.)

Group A contains, with the exception of the silkworm, the insects we have studied. Six families and ten species are represented.

Group B contains a list of insects reported to have polyhedral-sickness by the European investigators, Prowazek, Escherich, Wahl, Bolle, Bohm, etc.

Group C is made up of insects found in the United States that have a disease or diseases similar to wilt in many of its clinical aspects. With the exception of *Colias philodice* none of this group have been examined by us.

List of Species, with Their Distribution

Group A

I. Saturnidæ.
1. *Hemileuca olivia* Ckll.

II. Noctuidæ.
2. *Leucania unipuncta* Haw.
3. *Laphygma frugiperda* S. & A.

III. Dioptidæ.
4. *Phryganidia californica* Packard.

IV. Lymantriidæ.
5. *Porthetria dispar* L.
6. *Lymantria monacha* L.
7. *Orgyia leucostigma* A. & S.

V. Lasiocampidæ.
8. *Malacosoma americanum* Fabr.
9. *Malacosoma disstrja* Hübner.

VI. Bombycidæ.
10. *Bombyx mori* L.

Group B

I. Sphingidæ.
11. *Deilephila* sp.
12. *Smerinthus atlanticus* Auct.

II. Saturnidæ.
13. *Antherea pernyi* Guer.
14. *Antherea yama* Guer.
15. *Antherea mylitta* Drur.
16. *Philosamia cynthia* Drur.
17. *Saturnia pavonia major* O.

III. Noctuidæ.
18. *Prodenia litoxia*

IV. Lymantriidæ.
19. *Orgyia antiqua* L.

V. Notodontidæ.
20. *Harpyia bifida* Hubn.

VI. Geometridæ.
21. *Bupalus piniarius* L.

VII. Tortricidæ.
22. *Conchylis ambiguella* Hubn.

VIII. Tenthredinidæ.
23. *Lophyrus rufus* Ratz.

IX. Muscidæ.
24. *Calliphora vomitoria* L.

X. Dermestidæ.
25. *Dermestes lardarius* L.
26. *Anthrenus musæorum* L.

Group C

I. Pieridæ.
27. *Colias philodice* Godart.
28. *Eurymus eurytheme* Boisd.

II. Arctiidæ.
29. *Hyphantria cunea* Drury.

III. Noctuidæ.
30. *Alabama argillacea* Hubn.
31. *Heliothis obsoleta* Fab.
32. *Autographa gamma californica* Speyer.
33. *Autographa brassicæ* Riley[1]

IV. Notodontidæ.
34. *Heterocampa guttivitta* Wlk.

[1] January 23, 1915. Polyhedra were found in a caterpillar of *Autographa brassicæ* Riley during the past week.

Distribution—Group A

One of the most interesting phases of wilt besides its occurrence in so many widely different species, is its geographical distribution. We have already called attention (Dec., 1913) to its almost general occurrence in the Nun moth caterpillars and silkworm in Europe, where it is commonly known as "Polyederkrankheit" or polyhedral sickness.

The Gipsy Moth

Glaser (1915) has shown that the wilt is present throughout the entire gipsy moth infested area in New England.

Apple Tent Caterpillar

Observations on the tent caterpillars which we also previously reported have not been so general as those of the gipsy moth. However, more attention was given to them the past summer and one point in particular, near Lunenburg, Mass., was kept under observation. This was one of the gipsy moth observation points and consisted of a tract of mixed forest of perhaps fifty acres, surrounded by a dense swampy growth of many acres in extent. It was in this low growth that the apple tent caterpillars suffered almost complete annihilation from wilt. It first appeared in a chronic form, a few dying here and there in the webs. These would sometimes be spun over by the remainder of the colony before others died. It became epidemic about the time of complete defoliation (May 28–31, 1914), and within a few days thousands of webs were covered with dead and dying caterpillars, most of which were distinctly strawberry red in color. We searched this area for living caterpillars at this time and only a few were found. All of these when examined showed polyhedra in their blood. They too died in a few days.

Forest Tent Caterpillar

Though the wilt was also reported to have occurred in many places in the Forest Tent caterpillar, neither of us have seen more than a few typical cases from the field. Many caterpillars were sent in by the field men but only a few of them proved to have typical wilt.

The Army Worm

An outbreak of the army worm on Long Island, Boston Harbor, during August, gave us an opportunity to determine if wilt also occurred in that species. A trip was made to the Island through the courtesy of the officers of the penal institution of the city. Several hundred caterpillars were collected. Nothing resembling wilt was seen at the

time though many were dead or dying. The next day a typical case of wilt developed in one of the stock trays in the laboratory. The caterpillar was flaccid, hung by its prolegs and the skin broke at the slightest touch. A thin grayish liquid oozed out which proved on examination to contain almost pure polyhedra. Other cases of wilt developed in these trays from time to time. A number of deaths were also caused by bacterial infection as the post-mortem examinations showed.

We have had shipments of army worms from Nantasket, Mass., Hagerstown, Md., and Norfolk, Va. That the wilt was present in all of these places was shown by the typical cases of wilt in the shipping boxes at the time of their arrival at the laboratory from these places. J. A. Hyslop, of the Bureau of Entomology, who is located in Maryland, shipped 350 caterpillars (isolated in separate pill boxes) at one time. These were from seven different broods. Brood number five had 52 caterpillars, 50 of which were dead when we received the shipment. The remaining two died before the next day. There were also 30 dead in the other six broods, making a total of 82 dead with wilt out of 350 caterpillars.

Prof. Franklin Sherman, Jr., of North Carolina, recently informed us, after we had described the wilt to him, that some such malady did a great deal towards checking an outbreak of the army worm in North Carolina the past summer.

We have been more recently informed concerning the appearance of the wilt in two other outbreaks of the army worm, one in Illinois and the other in Oklahoma.

The Tussock Moth

During 1911 we made observations on the Tussock moth on Boston Common. A disease appeared among the second generation caterpillars which almost completely destroyed them. It had all of the external appearances of wilt and was so considered by us at that time, though no microscopical examination of the caterpillars was made.

The Tussock moth has been so scarce in New England since then that we have been unable to verify the observations of 1911.[1] The abun-

[1] Since the above was written we found some of the dried Tussock moth caterpillars taken on Boston Common, Aug., 1911, which had been stored with other insect materials. We examined them and the polyhedra were found to be plentiful and as fresh in appearance as though they came from caterpillars of the past season.

December 22, 1914, we received a letter from J. S. Houser, Associate Entomologist at the Agricultural Experiment Station, Wooster, Ohio, in which he says of *O. leucostigma:* "The accompanying photograph was taken July 7 at the time the caterpillars were supposed to be transforming to the pupal stage. The plot was practically defoliated, and for this reason attracted my attention; but much to my surprise I was

dance of this insect the past summer in Washington, D. C., provided the longed-for opportunity. Mr. E. R. Sasscer, of the Bureau of Entomology, kindly consented to send us caterpillars. About five hundred second generation caterpillars arrived from him the latter part of August. Beyond a few crushed in transit they appeared healthy and in good condition. Attached to some leaves which had served as food were two first generation pupæ which had failed to mature. These were examined and found to be full of polyhedra. Two days later a caterpillar was found dead, hanging by the prolegs. When grasped by a pair of forceps, its prolegs were left clinging to the side of the box. The case was as typical as any we had seen in the gipsy moth and the polyhedra were just as plentiful. A few of these caterpillars died each day until less than one dozen pupated out of more than five hundred caterpillars.

The Oak Caterpillar, Phryganidia californica

Early last spring we received word from one of Professor Kellogg's students at Stanford saying, "The Oak caterpillars are dying with a disease similar to wilt." We wrote him for material which he kindly sent; and though in poor condition when we received it, we were able to confirm his observations. Polyhedra were found in abundance in the dead caterpillars. According to his description of the disease it completely controls this pest at times and like wilt does the most good when defoliation has almost taken place.

The Range Caterpillar

Mr. H. E. Smith of the division of Cereal and Forage investigation has, the past summer, been working on the Tachinid parasites of the range caterpillar at the Melrose Highlands Laboratory.

On learning that we had found the wilt in other species of caterpillars besides the gipsy moth, he sent us a few Range moth caterpillars, one of which showed typical wilt symptoms. It proved on examination to be a very typical case. Since this was the last of his stock we have not had an opportunity to examine others, and therefore cannot say whether the wilt occurs naturally in the field or not. We will have to wait another season to determine this point.

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unable to find any pupæ. Upon examination, the dead caterpillars were found everywhere clinging to the branches, and also occurring in great abundance on the ground beneath. Some few caterpillars were yet alive, but were very sluggish. I collected some of these and carried them home, but they all died apparently from wilt," etc.

Mr. Houser enclosed some of the caterpillars he collected at that time. The abundance of the polyhedra in these caterpillars shows that they died of wilt.

Distribution—Group B

The insects contained in this group are reported on the authority of European investigators, who in the course of their studies of the disease of the Nun moth and silkworm caterpillars, either found a similar disease in these other species or by inoculation with the virus of diseased Nun or silkworms produced a similar condition in them.

Though details are generally lacking, enough information, in case of the majority of the caterpillars, is given to dispel any doubts one may have that the observers were not dealing with true polyhedral diseases. However, in regard to the production of the polyhedral-sickness in the larvæ of beetles and flies we do not feel so confident. Without going into too minute detail we should like to know whether the wilt ever occurs in these insects naturally. Also if all the typical symptoms are manifested in these individuals as in caterpillars. Until this and other more detailed information is forthcoming, we cannot come to any decision on the matter, further than to say all our own efforts in this direction have resulted negatively.

Distribution—Group C

We believe the species in this group should be reported at this time because they are all of more or less economic importance and particularly because they have a caterpillar malady which has checked them considerably, if not completely controlled them at some time or other. The various observers who have worked on the life histories and habits of these pests or have studied some special outbreak of them have made special mention of these maladies and their possible importance as factors in controlling these pests.

In looking over the histories of these diseases and in some instances getting the information at first hand from the investigators themselves, we were impressed with the similarity of many of them to wilt. With the exception of *Colias philodice*, we have not examined any diseased caterpillars of this group. A few Colias caterpillars which we tried to infect by feeding them army worm wilt died. They did not show the typical wilt symptoms. However, on examination a few polyhedra were found. We are inclined to believe that their presence in the Colias caterpillars was due to the unsatisfactory manner of feeding. Some of the material may have dried on the skin of the caterpillars. It was then washed off when the caterpillars were crushed for examination. Until this experiment is repeated several times or the wilt is found naturally in this species we cannot accept these results as final.

Comparative Study of Polyhedra

The question now arises whether or not there is more than one disease in the condition known as wilt. In Europe, as we have already pointed out, in a previous paper (Dec., 1913), there is a tendency to diagnose insect diseases, where polyhedra are present, as "Polyederkrankheit" or polyhedra-sickness. The idea is excellent, for though the diseases may not be identical they are similar in many respects[1] and until we know more about their cause certainly no harm can come from grouping them in this way.

We have adopted this scheme as will be seen from the preceding list of insects known to have polyhedra, and we have used wilt synonymously with "Polyederkrankheit."

Returning now to the question whether or not there is more than one disease concerned with wilt. We undertook a comparative study of the polyhedra in the different species of caterpillars: first, to see what light if any could be thrown on this phase of the problem; second, if by such a study we might determine the relation of the polyhedra to wilt.

We proceeded as follows: Smears were made either from fresh or dried wilt material. These were dried, fixed by passing through a flame, and stained by Giemsa's method. Five fields, of ten adjacent polyhedra each were drawn by camera lucida from each slide (one from each of the four corners and one from the center). These were drawn at the same magnification and at the height of the stage of the microscope. A stage micrometer was also projected and drawn. All measurements were then made with this enlarged scale. This projected scale was afterwards checked with measurements by an eyepiece micrometer.

We are not able at this time to present polyhedra from all the species named in group A. Unfortunately the few specimens of wilt of the Range caterpillar and army worm which we examined were not preserved. We can say however they differed in no material way from the polyhedra of the other eight species we have presented. (See Pl. 6, figs. 1–8).

As to the first part of the question. We must admit the comparative study of the polyhedra has added little of positive value; for with the exception of the silkworm caterpillars (Pl. 6, fig. 4, after Prowazek) which are distinctly rhomboidal, seldom pentagonal or hexagonal, there exists a striking similarity in shape between the polyhedra of the other seven species. If it is true that some of the polyhedra are more

[1] (1) Have polyhedra, (2) become flaccid, (3) hang by the prolegs, (4) body tissues become saponified, (5) and there is both a chronic and acute type in nature.

angular than others but with the possible exception of the tent caterpillars, this is characteristic of individual polyhedra in the same caterpillars, where they may vary from an almost spherical to a decidedly angular form.

Another striking fact is the great difference in size between the polyhedra in the different species studied. (Pl. 6, figs. 12–14.) Taking the average of five microscopic fields in each species studied, the polyhedra of the gipsy moth are the largest, measuring 3.4μ in diameter and those of the tussock moth the smallest, measuring 1.64μ in diameter. The polyhedra of the other species are intermediate in size. Glaser in his study of the polyhedra of the gipsy moth caterpillars found some measuring as much as 15μ in diameter, while in the same caterpillar there were many measuring 1.5μ and 2μ in diameter with all possible gradations between these two extremes.

As to the second part of the question, what relation have the polyhedra to wilt? We have previously stated (Dec., 1913) that the polyhedra were reaction products, a view also held by many European investigators. This view we further believe is strengthened by the present study of the polyhedra.

A further study was made of some polyhedra taken from caterpillars which died in experiments of cross infection. (Pl. 6, figs. 9–11.) That is, apple tent caterpillars were fed with gipsy moth wilt and gipsy moth caterpillars were fed with Nun wilt. A number of such infections were tried but the reciprocal infections were not made. Until this is done we cannot express a definite opinion on the results we have obtained so far. We present it more to call attention to or to show what might be done in the future in an experimental way, that might give the solution to the problem.

We wish at this time to thank all those who have in any way aided us in this work; especially those who have sent us material from the field.

Summary and Conclusions

1. Wilt occurs in many widely different species of insects.

2. The clinical aspects of wilt are very similar in all the species of caterpillars studied by us.

3. Wilt first appears in a chronic form, as conditions become more unfavorable it becomes acute, and finally terminates in a general epidemic.

4. There is a striking similarity in shape between the polyhedra of the different species of caterpillars given in Group A.

5. The polyhedra in the different species vary greatly in size.

6. The great difference in size which exists between polyhedra in the same caterpillar tends to strengthen our view that the polyhedra are reaction bodies.

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Explanation of Plate 6

Note.—Each figure consists of one microscopic field of ten adjacent polyhedra. Two measurements are given under each figure. The first refers to the average size of the ten polyhedra given in each figure. The second is the average of five such microscopic fields.

Fig. 1. Polyhedra of a Gipsy moth caterpillar.
(Average size 3.4μ and 3.39μ)

Fig. 2. Polyhedra of a Nun moth caterpillar.
(Average size 2.65μ and 2.43μ)

Fig. 3. Polyhedra of a Forest tent caterpillar.
(Average size 2.6μ and 2.5μ)

Fig. 4. Polyhedra of a silkworm.
(After Prowazek) Mag. 1400 diam.

Fig. 5. Polyhedra of an Apple tent caterpillar.
(Average size 2.05μ and 2.2μ)

Fig. 6. Polyhedra of a Tussock moth caterpillar.
(Average size 1.5μ and 1.64μ)

Fig. 7. Polyhedra of an army worm.
(Average size 2.3μ and 1.88μ)

Fig. 8. Polyhedra of a Phryganidia caterpillar.
(Average size 1.6μ)

Fig. 9. Polyhedra of a Gipsy moth caterpillar fed Nun wilt.
(Average size 2.5μ and 2.1μ)
Fig. 10. Polyhedra of a Gipsy moth fed Phryganidia wilt.
(Average size 2.15μ and 2.1μ)
Fig. 11. Polyhedra of an Apple tent caterpillar fed Gipsy moth wilt.
(Average size 2.35μ and 2.2μ)
Fig. 12. Polyhedra of a Gipsy moth caterpillar.
(Showing two extremes)
Fig. 13. Polyhedra of an Apple tent caterpillar.
(Showing two extremes)
Fig. 14. Polyhedra of a Forest tent caterpillar.
(Showing two extremes)

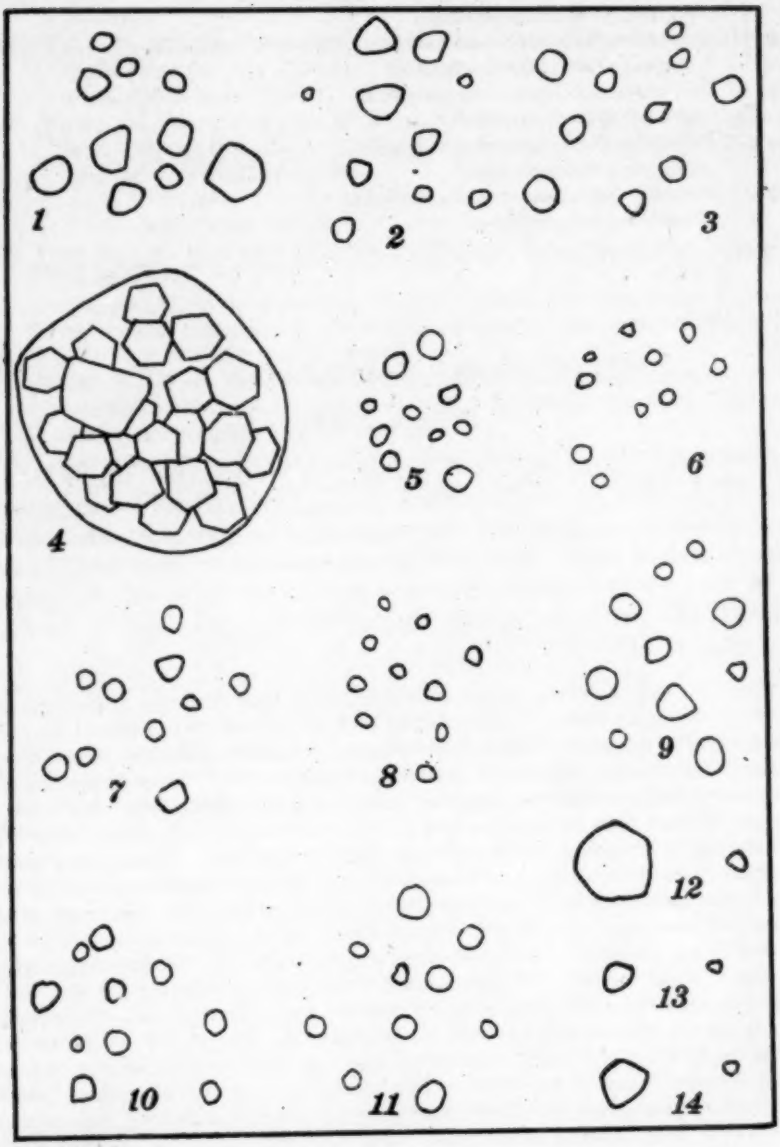
Drawn by camera lucida. (Ocular 6, Oil immersion $\frac{1}{12}$, tube length 160 mm.)

MYCODIPLOSIS MACGREGORI N. SP.

By E. P. FELT, *Albany, N. Y.*

The small midge described below was reared July 16, 1914, by Mr. E. A. MacGregor, Batesburg, S. C., from red spider on cotton, and at the time of rearing it was supposed to be identical with *Arthrocnodax carolina* Felt. This new species runs in our keys to *M. tsugæ* Felt, from which it may be easily separated by the equal and shorter stems of the fifth antennal segment and marked differences in the male genitalia.

Male. Length 1.2 mm. Antennæ one-fourth longer than the body, sparsely haired; fuscous yellowish; 14 segments, the fifth having the two portions of the stem nearly equal, each with a length one-half greater than its diameter; terminal segment with the basal enlargement oblate, the basal portion of the stem slender and with a length about twice its diameter, the distal enlargement stout, with a length one-half greater than its diameter and roundly tapering to an irregular, finger-like process less than one-half the length of the distal enlargement. Palpi; first segment irregular, the second with a length one-half greater than its diameter, the third one-half longer than the second, more slender, the fourth nearly twice the length of the third and somewhat compressed. Mesonotum fuscous yellowish. Scutellum and postscutellum yellowish. Abdomen light fuscous yellowish, the genitalia slightly fuscous. Wings hyaline. Halteres whitish transparent. Coxæ and femora mostly pale yellowish, the tibiæ slightly darker and the tarsi a light straw; claws slender, evenly curved, the anterior and mid claws unidentate; pulvilli reduced, about two-thirds the length of the claws. Genitalia; basal clasp segment long, slender; terminal clasp segment rather short, stout, nearly straight, the dorsal plate short, deeply and roundly emarginate, the lobes tapering to a broadly roundly apex; ventral plate moderately long, tapering at the basal third, the distal portion of the sides nearly parallel, the apex broadly rounded and with two pairs of large, latero-posterior setæ; style long, slender, acute Type Cecid. a2601.



M. T. Sheerin.

POLYHEDRA OF VARIOUS CATERPILLARS

A NEW SARCOPHAGA PARASITIC ON ALLORHINA NITIDA[1]

By J. M. ALDRICH, *Assistant in Cereal and Forage Insect Investigations, U. S. Bureau of Entomology, Lafayette, Ind.*

The publication of the following new species is desired in order that it may be referred to in a forthcoming article on the host.

Sarcophaga utilis new species.

♂. Robust black species with first vein bare, dorsocentrals much reduced and hardly differentiated except the hindmost two pairs, no acrostichals except the prescutellar pair, hind tibiæ not with long, erect villosity; and hypopygium red except for an indistinct blackish band across the middle of the first segment.

Head broad, the front at narrowest equal to ⅓ of one eye, black above, the frontal stripe wide, black; lower part of the parafrontals together with the parafacials and anterior part of bucca rather grayish-yellow pollinose, a darker reflecting spot laterally from root of antennæ; beard mixed black and yellowish; bucca about half the eye-height in profile view; proboscis ordinary, palpi black; vibrissæ inserted well above oral margin, almost on a level with lower edge of eye. Outer vertical bristle well developed, almost like inner; three fairly regular rows of black cilia behind the compound eye; parafacials less than half as wide as median portion of face, with an oblique row of small bristles close to orbit and a few scattering; antennæ entirely black, third joint rather short and wide, twice the length of the second; arista loosely plumose for three-fifths of its length.

Fig. 9.—*Sarcophaga utilis* n. sp., male genitalia.

Thorax black, gray-pollinose, with the usual three black, sub-shining stripes, of which the middle one broadens out on the scutellum and is accompanied anteriorly by a fine line each side; another pair of stripes on the sides of the mesonotum, abbreviated in front, extend to the metanotum; pleuræ lightly pollinose, mostly blackish; scutellum large, with only two lateral pairs and a smallish apical pair of macrochætæ, together with a medium-sized subdiscal pair; halteres yellow, the stem and base of knob brownish; calypters white.

Abdomen gray-pollinose with the usual tessellated appearance, when viewed from behind showing three longitudinal blackish stripes; the hind margin of the fourth segment red in ground color; second segment without median marginal macrochætæ, third with a single pair, fourth with a row of about 18 across the dorsum.

The hypopygium normally retracted is rather large, red, the first segment more or less blackish on the base of the exposed part (really the middle), without row of bristles apically; second segment red, globose, with long blackish hair, more dense about the forceps. When unfolded the genitalia usually (in seven of eight examined) have the terminal part of the penis enveloped in a gelatinous mass, so that its structure cannot be made out; the accompanying drawing is made from a specimen that had been boiled in water, which successfully freed it from this substance. The long, abundant, backward-directed hair is omitted from the main part of the forceps. The drawing was made shortly after boiling, while the specimen was plump, but it

[1] Published by permission of the Chief of the Bureau of Entomology.

did not undergo much change in drying. The two apical sharp points of the penis are paired structures, as in fact all the other parts shown are. The tips of the forceps are very characteristic, being covered with erect, short, stiff hairs so that only a little of the black apex is visible; the rest of the forceps before the erect hairs is red in color.

Wings subhyaline, small crossvein not clouded, third vein bristly halfway to it or sometimes a little more; apical cell rather widely open; epaulet black, subepaulet pale yellow. Legs entirely black; pulvilli blackish, large but shriveled in drying, all claws elongated, fourth tarsal joint very short, less than half the fifth; hind femur with intermediate row of short bristles; middle femur with short posterior comb (below near tip).

Length to hypopygium, 8–9 mm.

♀. Front wider, equaling one eye; palpi more clavate; dorsocentrals a little better developed, four behind the suture, of which the anterior two are small; scutellum without apicals; tip of abdomen red beginning with the last third or more of the fourth segment; fifth segment deeply notched above and with an almost slit-like aperture behind, which is fringed with small bristles above; spiracles of fifth segment visible; claws and pulvilli of medium size, the latter dark yellow; hind femora without intermediate row of bristles; two pairs of orbital bristles.

Length, 7–13 mm.

Material examined: One male and one female, Norfolk, Va., Sept. 6 and 18, 1914, bred from pupa of *Allorhina nitida* by D. E. Fink; four males, Logansport, Ind., June 30, 1914 (Aldrich); two males, Lafayette, Ind., Sept. 16 and Oct. 9 (Aldrich); four males and one female, Tifton, Ga. (Hough Collection); four females, Opelousas, La. (same); one male, Agricultural College, Mich. (same); one female, Orlando, Fla. (same); and one from Pullman, Ill. (same).

The type is selected from the Logansport lot, but the drawing is from the paratype bred from Allorhina, as it showed after boiling the details of the penis, but was not in other respects suitable for the type.

Two males and two females (including type) deposited in the U. S. National Museum.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1915

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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The Philadelphia meeting has become history. Those privileged to attend can hardly class the gathering as other than one of the most pleasant and profitable. The program was full but not so overcrowded that discussion was impractical and we have yet to learn of serious conflicts between the meetings of closely allied societies. Material progress was made with the Index of Economic Entomology. The plan has been carefully outlined and compilation has already started. There was a large increase in the membership and the finances of the JOURNAL have been put upon more substantial basis. These are all creditable achievements and continuations of earlier adopted policies.

The design for an official seal for the Association of Economic Entomologists should receive careful consideration, and, as mentioned in the report of the Executive Committee, suggestions are desired by those with whom the final decision must lie. *Melanoplus spretus* has been suggested as particularly well qualified to occupy a prominent place on the seal. Its claims to this distinction may be briefly stated as follows: It is an important insect pest and its activities in earlier years resulted in the organization of the United States Entomological Commission—a pioneer in the exhaustive and fruitful studies so characteristic of the present day. The ravages of this insect raised the public estimation of applied or economic entomology from a tolerated and presumably somewhat beneficial calling to one of great practical importance—a rating abundantly justified in the developments of later years and attested by the present wonderfully efficient Federal Bureau of Entomology with its extended ramifications and the numerous state agencies employing skilled scientists in the study of insect

problems. The Rocky Mountain Locust really started the comprehensive entomological work of the present day and as a consequence was an important factor leading up to the organization of this Association. Furthermore, this insect is a characteristic American species with close allies so widely distributed throughout the world, that the casual observer in almost any country would associate the illustration of this species with familiar, injurious insects, even though he were unable to decipher the lettering on the seal.

Reviews

Some South Indian Insects and Other Animals of Importance, considered especially from an economic point of view, by T. BAINBRIDGE FLETCHER. Printed by the Superintendent, Government Press, Madras, India. 4to, p. i–xxi, 1–565, figs. 440, plates 50. 1914.

This large and rather weighty volume has an introduction of 74 pages dealing with the structure, classification and ecology of insects. The chapter on the control of insect pests is thoroughly modern and of interest to entomologists of America largely because of the emphasis laid upon hand collecting, a method particularly adapted to regions where there is an abundance of cheap labor. Here are also found excellent directions for the destruction of termites. The table of equivalent weights and measures is a valuable feature, especially where a double or treble system exists.

Chapters 12–23 deal with the principal crop pests, the groupings being somewhat unfamiliar to American eyes, namely, Caterpillar Pests of Crops, Grasshoppers, Crickets and Termites, to mention a few. There is a brief chapter on Household Insects, the paragraph dealing with wasps and bees having a distinctly local color. The disease-carrying insects naturally receive considerable attention and in the chapter one finds a list of Anopheles with the malaria and filaria carriers indicated and a tabulation of the principal diseases of India known to be carried by insects. The chapter on some other animals briefly discusses native mice, rats, fruit-eating bats, birds and snakes, to mention a few of the more important. This portion of the work ends with a list of the principal crops and their enemies.

The remainder of the volume, pages 264–547, consists of very brief accounts summarizing the biological data and arranged on a systematic basis. The numerous excellent text illustrations and the large series of colored plates, the latter mostly reproduced from *Indian Insect Life*, *Fasaler Poka* and *The Agricultural Journal of India* add greatly to the value of the work, a compilation which must prove of much service to workers in similar faunal regions.

Current Notes

Conducted by the Associate Editor

W. F. Turner, formerly assistant entomologist at the Alabama Station, is now at Vienna, Va.

The degree of doctor of philosophy was conferred on C. H. T. Townsend, October 29, 1914, by George Washington University.

An index to Circulars 101 to 173 of the Bureau of Entomology will soon be issued by the United States Department of Agriculture.

A. W. Jobbins-Pomeroy left for England on October 28. From London he will proceed to his post in Southern Nigeria in a short time.

Mr. W. W. Yothers, Bureau of Entomology, reports some very satisfactory demonstration orchard results in the control by sprays of the white fly and rust mite.

T. C. Barber, of the Experiment Station at Tucuman, Argentina, who has been in New Orleans for some weeks, is about to return to his post.

The work of Mr. J. R. Horton, Bureau of Entomology, in the New Orleans citrus district, principally with the Argentine ant, is developing control results of much promise.

Dr. Burton N. Gates, assistant professor of beekeeping at Amherst, Mass., is president of the National Beekeepers' Association, which meets February 16–18 at Denver, Colo.

Mr. C. H. Hadley, Jr., assistant entomologist at the New Hampshire College and Station, has resigned to accept a research position at Cornell University beginning January 1, 1915.

F. C. Bishopp, Bureau of Entomology, made an extended trip to the Dakotas and other states in connection with reports of heavy loss arising from insects which attack horses and cattle.

According to *Science* the following entomologists connected with the British Museum are serving at the front in the European war: Captain E. E. Austen (Diptera); Lieutenant N. D. Riley (Lepidoptera), and private K. G. Blair (Coleoptera).

R. W. Moreland and G. A. Runner, Bureau of Entomology, have been detailed to examine cotton fields in the vicinity of mills which have recently received foreign cottons, to determine whether the pink boll worm has become established.

C. L. Metcalf, for the past two years assistant entomologist in the State Department of Agriculture, Raleigh, North Carolina, resigned October first to accept the position of assistant professor of zoölogy and entomology at Ohio State University.

Mr. A. B. Duckett, scientific assistant, Bureau of Entomology, is engaged in a preliminary investigation of the so-called "Argentine corn weevil" in New York City and vicinity.

Mr. F. M. Wadley, temporary field assistant, Bureau of Entomology, during the summer, has returned to his duties as student at the State Agricultural College, Manhattan, Kansas.

Mr. H. M. Russell, Bureau of Entomology, has been granted indefinite leave of absence and expects to engage in farming in the vicinity of Phoenix, Ariz., where he was formerly stationed as entomological assistant.

Dr. Jas. A. Nelson, Bureau of Entomology, has completed his work on the development of the honeybee in the egg, on which investigation he has been engaged for some time. The paper will be published outside the Bureau.

Mr. Clarence R. Cleveland, a graduate of the University of Wisconsin, class of 1912, and assistant at Wisconsin Agricultural Experiment Station, has been appointed assistant in economic entomology at the Agricultural Experiment Station, Durham, N. H., in place of C. H. Hadley, Jr., resigned.

Mr. J. W. Bailey, Bureau of Entomology, who has been engaged for a large part of the season in investigations of the onion thrips and other insects in southern Texas, has returned to the Mississippi Agricultural College to resume his studies.

Mr. Thomas H. Jones has resigned his position at Rio Piedras, Porto Rico, and is stationed now at Baton Rouge, La., for the study of insects injurious to truck crops and stored products in Louisiana, in coöperation with Mr. E. S. Tucker, State Entomologist.

Mr. H. B. Scammell, of the Bureau of Entomology, will spend the winter at his headquarters, Pemberton, N. J., where he will make observations in connection with investigations of cranberry insects, giving special attention to questions connected with flooding of cranberry bogs, hibernation of cranberry insects, etc.

W. D. Pierce, Bureau of Entomology, investigated the dispersion of the boll weevil in the eastern part of the cotton belt early in October, and later began working along the same line west of the Mississippi River. The work in the east is being conducted by F. L. McDonough.

Mr. E. W. Rust, a graduate of Stanford University and for a period an assistant of Mr. Townsend's in Peru, has joined the inspection service of the Federal Horticultural Board, and will assist Mr. Sasscer and Mr. Sanford, the latter with the Bureau of Entomology, in this work.

H. A. Morgan, Dean of Agriculture in the University of Tennessee, made a trip to Louisiana during October at the request of the Bureau of Entomology. He visited the laboratories of Mound, Tallulah, and New Orleans. W. D. Hunter accompanied Professor Morgan on this trip and also visited the laboratories at Dallas and Victoria, Tex.

Professor E. Dwight Sanderson, Director of the Station and Dean of the College of Agriculture, West Virginia University, Morgantown, W. Va., has resigned to take effect September 1, 1915. Professor Sanderson was formerly entomologist of the New Hampshire Station. It is stated that he will take up graduate studies, in some subject other than entomology, in one of the large universities.

Mr. R. S. Woglum, Bureau of Entomology, presented at the recent Fruit Growers Convention at Los Angeles a very interesting paper on fruit injury during fumigation, showing that such injury is due principally to the hydrocyanic-acid gas entering through abrasion or accidental injury to the fruit rather than to the emanations of sulphuric acid.

Mr. J. D. Neuls, Bureau of Entomology, will conclude his life-history studies of date scale insects at Mecca by the end of this year and will then resume his former detail as an assistant in the citrus fruit laboratory at Pasadena with Mr. Woglum. This laboratory is the one formerly located at Whittier.

The work on the control of the house fly which has been under way in Washington during the season will be continued at New Orleans for several weeks. E. R. Barber will conduct the experiments at New Orleans. Mr. Hutchinson will complete the work at Washington and inaugurate an extended series of experiments to determine certain points about the hibernation of the fly.

The Bureau of Entomology has established a field station at West Springfield, Mass., about two miles from the center of Springfield and near the Connecticut line where investigations on cereal and forage crop insects will be conducted for New England. Mr. Harrison E. Smith has been placed in charge, and the buildings are now being erected and will be occupied by the Bureau in February.

The biological investigations in California of the grape *Phylloxera*, by the Bureau of Entomology, have now been pretty well completed, and Mr. W. M. Davidson will spend the winter in Washington, and will be engaged in the preparation of his report and necessary illustrations. The field work with remedial measures against the *Phylloxera* will be continued under the direction of Mr. R. L. Nougaret.

Mr. R. A. Cushman, Bureau of Entomology, who is engaged in an investigation of Hymenopterous parasites of the grape berry moth and other deciduous fruit insects at North East, Pa., is just now on a trip of investigation through Ohio, Indiana, Michigan, and will later visit the New England States to determine the distribution and seriousness of the apple seed Chalcis.

Mr. Wm. B. Parker, formerly entomological assistant engaged in investigations of insects injurious to sugar beets, hops and stored products, has severed his connection with the Bureau of Entomology and is now engaged as agricultural adviser of the University of California, with headquarters at Ventura, Cal. Mr. Roy E. Campbell assumes the position made vacant by Mr. Parker at the Sacramento station.

A greenhouse 16 feet 8 inches by 33 feet 10 inches has been built in the yard of the insectary of the Bureau of Entomology, to be used for experiments with greenhouse insects, including their control by means of fumigants and other remedies, and is expected to afford much greater opportunity for testing of insecticides against the more difficult pests to control.

During October a report on the occurrence of the pink boll worm of cotton at Madison, Fla., was received by the Bureau of Entomology. Immediate steps were taken by several offices in the department to eradicate the pest, but it was found on investigation by W. D. Pierce that the insect was *Batrachedra rileyi*, which occurred in unusual numbers in bolls affected by the anthracnose disease.

T. E. Holloway, Bureau of Entomology, reports some striking results from the experiments, to determine the effects of the burning of sugar-cane trash during the fall, on the sugar-cane borer and its parasites. The infestation by the borer was found to be much lighter where the trash was not burned. Presumably this is due to the fact that the burning of the trash destroys large numbers of parasites.

The outbreak of *Alabama argillacea* during the past season seems to have been the most severe for many years. In parts of Arkansas and Mississippi all of the green

portions of the cotton plants were destroyed in October. Ordinarily this outbreak would have attracted more attention. The peculiar conditions surrounding the cotton crop of the present year, however, were such that the insects' injury was not generally considered important.

The studies of the codling moth in Maine, carried out by the Bureau of Entomology during the past two years, under the direction of Messrs. E. H. Siegler and F. L. Simanton, have been completed and a report, giving the results of the work, will be prepared the present winter. It is planned to continue the laboratory in Maine, and to give special attention to investigations of the apple bud-moth and apple maggot.

Mr. E. R. Sasscer recently made a trip of inspection for the Federal Horticultural Board, including all the ports of entry along the Mexican border of the United States, in relation to the Mexican fruit-fly quarantine and also visited the special experiment stations under tropical and sub-tropical insects at Mecca and Pasadena, concluding his trip with an inspection of the Department's introduction garden at Chico, Cal., and after his return several introduction gardens in Florida.

The Annual Public Address of the Entomological Society of America was given Wednesday evening, December 30, by Dr. S. A. Forbes, State Entomologist of Illinois. His subject was "Ecological Foundations of Applied Entomology." The meeting was held in the lecture hall of the Academy of Natural Sciences. Following the address of Dr. Forbes a history of the Entomological Society of America was given by Dr. Henry Skinner of Philadelphia. Dr. Skinner also showed lantern slides of some of the early entomologists of America. The exercises were followed by a smoker given to all visiting entomologists by the entomologists of Philadelphia.

As a result of an examination held on April 14, for scientific assistant, and on June 3, for gypsy-moth assistants, the following 20 men were appointed in the Bureau of Entomology. Messrs. D. W. Jones, H. A. Preston, J. V. Schaffner, Jr., and W. B. Turner as scientific assistants; W. A. Collins, I. L. Bailey, C. W. Minott, H. W. Vinton, D. G. Murphy, E. A. Proctor, A. M. Wilcox, L. E. Gibson, K. W. Brown. H. R. Gooch, A. W. Young, W. A. Shinkwin, H. I. Winchester, H. E. Partridge, C. B. Russell and D. D. Landers as gypsy-moth assistants.

Mr. A. J. Ackerman, Bureau of Entomology, engaged in nursery insect investigations, West Chester, Pa., will make observations on fumigation methods as practiced in nurseries, paying especial attention to the construction of the fumigatorium, dosage and other questions of practical importance. Mr. Ackerman spent the late summer and fall at West Chester, Pa., in a careful study of the cause of stop-back of peach. His observations indicate that this is largely due to attack by the tarnished plant bug, and that the peach bud-mite *Tarsonemus waitei*, is perhaps but little, if at all, concerned.

On October 23, 1914, the Secretary of Agriculture declared a quarantine on all shipments of stone and quarry products from the gypsy-moth infested area in New England to uninfested territory. Material of this sort cannot be accepted by transportation companies unless it has been inspected and certified to be free from the gypsy moth. The work is being carried on in connection with the quarantine division of the gypsy-moth work by Mr. D. M. Rogers of Boston, Mass. This quarantine should effectively prevent the distribution of this dangerous insect on shipments of stone and quarry products, and it is an important step in the campaign which is being carried on to prevent its spread.

The apparatus used by the Bureau of Entomology in the investigation of bees in winter at the University of Pennsylvania, Philadelphia, during the past two winters has been moved and is now installed in the laboratory at Drummond, Md. A small room has been fitted up as a "bee cellar" in the basement, in which the temperature changes will be slow, the room being completely surrounded by planer shavings one foot thick. The wiring for the temperature readings is now being installed, thermo-couples being used for this purpose. The special scales for taking hourly weighings of a colony of bees during winter have been installed in a room on the first floor of the laboratory and arranged to weigh a colony in the basement.

D. L. Van Dine, of the Bureau of Entomology, has returned to Washington from his field station at Mound, La. During the season he made a careful study of the relation of malaria to agriculture. In this work detailed information was obtained regarding the incidence of malaria and the time loss in each of seventy-four families. A study was also made of mosquito density in the various classes of habitations and the breeding places in the immediate vicinity of the houses were determined. An experiment was performed on a considerable scale in removing the cans, bottles and other receptacles in the vicinity of the houses, and filling disused wells and old cisterns to determine the effect of such measures on mosquito density. Mr. Van Dine presented a paper on his work on malarial mosquitoes at the meeting of the Southern Medical Association at Richmond, Va., on November 9.

At the Boston Domestic Science and Pure Food Exposition held at Mechanics Building, Boston, Mass., during the month of October, a large Government exhibit was installed, showing the different activities of the United States Department of Agriculture. In connection with this exhibit a special display was prepared by the gypsy moth branch of the Bureau of Entomology. This included maps showing the infested district which is under quarantine on account of the gypsy moth and the brown-tail moth, and the areas where parasites have been colonized and recovered were also illustrated. Several trays containing live parasites breeding on gypsy moth eggs and a display of live *Calosoma* beetles were also included. Posters, and post cards, illustrating the gypsy moth and the brown-tail moth, together with some of their imported natural enemies, were distributed. A large number of visitors manifested a great deal of interest in the exhibit. Mr. R. Wooldridge, who is stationed at the Gypsy Moth Laboratory, Melrose Highlands, Mass., was in charge of the gypsy moth exhibit.

The Entomological Society of America elected the following persons as honorary fellows at its Philadelphia meeting: John Henry Comstock, Charles J. S. Bethune, Charles Henry Fernald, and Eugene Amandus Schwarz. The following were elected as fellows: Nathan Banks, J. Chester Bradley, W. E. Britton, C. T. Brues, H. T. Fernald, Glenn W. Herrick, J. S. Hine, O. A. Johannsen, A. L. Melander, A. P. Morse, P. J. Parrott, Edith M. Patch, A. L. Quaintance, J. A. G. Rehn, W. A. Riley, Annie Trumbull Slosson, E. M. Walker, H. F. Wickham, and E. B. Williamson. Dr. E. S. Van Dyke was elected as a local secretary to plan and look after the summer meeting of the society to be held in San Francisco in 1915. The executive committee recommended the preparation of a serial publication to be issued under the name of the Thomas Say Foundation, which will include catalogues of North American insects and monographs and memoirs of the same. A preliminary editorial committee consisting of J. M. Aldrich, Nathan Banks, Morgan Hebard, A. D. MacGillivray, and E. P. Van Duzee was appointed to look after the foundation of this serial. The society added one hundred and nine new members to its membership list.

A state meeting of the entomological workers in Ohio Institutions was held in the Botany and Zoölogy Building of Ohio State University, Columbus, Ohio, January 15. The business consisted of effecting a temporary organisation and the question of permanent organization was discussed. The following papers were presented: Review of Entomological Work in Ohio, by Herbert Osborn; General Reports from Heads of Departments, Organizations; H. A. Gossard, Experiment Station; N. E. Shaw, Division of Orchard and Nursery Inspection; H. Osborn, Department of Zoology and Entomology. Ten-Minute Reports by Individual Investigators. (1) Experiment Station. J. S. Houser—Coccidæ of Ohio; R. D. Whitmarsh—*Nezara hilaris* and related species; W. H. Goodwin—Grapeberry Worm Control; J. L. King—Peach Borers; D. C. Mote—Ox Warble Fly. (2) Division of Nursery Inspection. E. J. Hoddy—Result of Tests of Insecticides and Fungicides; W. H. Evans—Inspection of Imported Nursery Stock; H. J. Speaker—Gypsy Moth Outbreak in Ohio; E. R. King—Apiary Inspection and Bee Diseases. (3) Department of Zoölogy and Entomology, Ohio State University. Jas. S. Hine—Apiculture Work, Diptera of Ohio; Wm. M. Barrows—Spiders of Ohio; C. L. Metcalf—Insects Related to Health; W. J. Kostir—The Catalogue of Ohio Orthoptera; C. J. Drake—Hemiptera-Heteroptera of Ohio. The meeting closed with a discussion of the projects to be continued and inaugurated during the coming year.

Scurfy Scale on Norway Maple (*Leucaspis japonica* Ckll.) Last fall we received from the Frost & Bartlett Company, Stamford, Conn., twigs and leaves of Norway maple and also privet showing a somewhat severe infestation by the above-named insect. It was reported as having caused considerable injury. The scale has much the shape of that of *Lepidosaphes ulmi* Linn., except that it is somewhat broader. It is a small species, being only 1.5 to 2 mm. long and a dull grayish white—pure white when the scale is first secreted. The twig submitted for examinaton was thickly infested, while small numbers of the scale insects had established themselves at the base of the principal leaf veins, with scattering individual aranged along the veins to the middle of the leaf. The absence of the tricarinate male scales characteristic of Chionaspis, serves at once to distinguish the common scurfy scale from this much rarer form.

The literature relating to this species is very scanty. It was described in 1897 by Professor Cockerell from specimens taken on broom, shipped from Japan, by Mr. Alex. Craw the preceding year, and subsequently it was found by Mr. Craw on *Magnolia soulianа* and maples, species not indicated, from the same country. There are specimens in the New York State collection on orange, received from Mr. I. Kuwana, Japan, which, while closely allied, do not appear to be identical with the form taken on Norway maple.

E. P. Felt.

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